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The Yale Bowl

YALE'S new stadium, aptly named the "Bowl," is a departure from previous designs for this class of structure. It presents advantages, too, so great that it won against great, though friendly, opposition. The first plans were for a structure of reinforced concrete members, built entirely above ground. As a substitute a design wherein half on the structure lies in an excavation and half on the resulting fill was proposed, the cost being about one-half that of the first design. This scheme was adopted and the structure is now under way. The details, as given on page 369, warrant the careful study of those who are or may be confronted with a similar problem.

Closing a Record Orifice

THE closure of the gap beneath the Port Angeles Dam on the Elwha River, described on page 372 of this issue, is a most remarkable engineering feat. With a rushing river passing under the huge masonry block that was supposed to form the dam, the possibility of stopping the flow seemed quite remote. The surprising merit of the plan adopted is its simplicity. The problem was easily stated—"stop the hole"; but ingenuity was needed in devising the method by which this should be accomplished. Mr. Mead's decision was to put down a barrier beyond the toe, which would intercept the material thrown in at the heel. Then huge blasts on the hillsides above the dam furnished the material with which the gap was quickly and successfully closed.

What the Railroad Engineer Lacks

ECONOMICS, finance and accounting—these are matters to which President Wendt at the recent convention of the American Railway Engineering Association repeatedly urged the members to give more attention. While the responses were not as enthusiastic as might have been desired, the tendency is certainly in that direction. Several of the maintenance committees had economics of labor specifically assigned to them for study, and the fact that none of them have ventured to make a complete report shows their appreciation of its magnitude and importance. The association has probably always been more keenly alive than some other societies to the fact that the engineer who solves his technical problems ever so well and stops there is falling far short of what he should do. However, there is yet much to be desired along these lines. With the Federal evaluation fairly started, the various phases of finance and accounting assume great importance. At the annual banquet Charles E. Prouty admitted his growing faith in the judgment of the engineer in the broad problems of the work as well as in the technical matters. The engineer who proves his knowledge along these lines will be able to render great service to his road in the knotty problems that arise as the evaluation proceeds.

Railway Engineering Association

TECHNICALLY the convention last week of the American Railway Engineering Association was somewhat disappointing. There was no scientific paper that invoked such discussion as followed the report last year on train resistances and tonnages. The recommendation of this same committee that a regular staff be employed to continue the study of economics of railway location was received in silence, as was that of the minority that further study be made of the proper apportioning of maintenance expenses to passenger and freight tonnage. The comprehensive analysis of secondary stresses elicited a special vote of thanks, but none ventured to discuss it. Neither was any opinion voiced as to the study of speeds of trains on curves and level turnouts, while frank doubt was expressed as to the utility of tests on the bearing power of soils. The discussion on screw versus cut spikes, it is true, excited much interest. In general, however, the members preferred to debate questions of policy, such as the use of guard rails on bridges, and the inscriptions on crossing signs. Attention to these things is indicative of the growing recognition of the safety movement and the public's viewpoint. While these are important it would seem that the scientific aspects of railroading should not be neglected.

Tallulah Falls Plant

THE Tallulah Falls hydroelectric plant, notable for having the highest head in the South, displays several features to which the attention of hydraulic engineers should be directed. Most striking is the use of automatic flashboards of a type not previously used here but employed successfully in Europe for six or seven years. The rack cleaner is an innovation here. It seems, however, that it might better have been located on the racks in front of the headgates rather than on the second set, for the first set is the more likely to need cleaning. Of course, when water is passing over the dam the velocity past the racks will be sufficient to prevent the collection of debris. Exception should be taken, too, to several other features. One of the drawings in the first part of the article, published last week, indicates that water flowing over the flashboards strikes the concrete with considerable force. It would not be surprising if after months' operation with water going continually over the structure it should be found to be erroded, at least to the extent of pitting. Furthermore, the curve of the toe is such that the water is discharged in a downward direction. There are experiences sufficient to indicate that this is a decidedly questionable design, for even with lower heads and horizontal discharge of the water there has been erosion. The installation, too, uses turbines under the highest head in this country. It will be interesting to know how the runners stand up. One might expect the wear on them to be excessive. Data on this point six months hence will be of value to hydraulic engineers.

Miami Valley Situation

THE plans proposed by the Dayton Flood Committee for the protection of the Miami valley are described briefly in this issue. From an examination of the data this journal is convinced that the reservoir scheme is the only one financially feasible. The studies have been most thorough, embracing not only the American and foreign literature on flood prevention, but both American and European data on rainfall and stream flow. No matter how meritorious a proposal, however, there always will be opposition. Such is true in Ohio and before the technical merits of the case can be considered the lawyers will fight out the constitutionality of the measure. While the opposition seems to be well fortified with legal talent it has not seen fit to engage engineers either to study the problem and devise an alternative or pass on the plans proposed by the Dayton committee. Furthermore, should the law be upheld the question before the court will be entirely an engineering one. While this journal feels that the reservoir plan should prevail, it believes that the opposition must secure competent technical advice.

Reservoirs in the Ascendant

ONE feature in connection with the flood prevention plans prepared by the Morgan Engineering Company for the Miami valley and approved, so far as plans had then been completed, by Messrs. Meade, Alvord and Woodward, is particularly worth noting—namely, that whereas these engineers believed at the outset that channel improvements were the proper solution of the Miami flood problem, they became convinced on careful study that reservoirs should be used. This repeats the history of the Pittsburgh investigation. There, too, the engineers believed at the start that other methods than reservoirs would offer the best solution. The data gathered and the European experience studied brought them around to the endorsement of a reservoir system. The significance of these changes in attitude are too great to pass by without emphasis. It does not mean, of course, that these engineers believe that reservoirs are feasible for the prevention of floods in any watershed, but only that under the particular conditions studied, they are superior to other methods. It is a safe statement that until the Pittsburgh and the Dayton conditions were studied, American engineers, with few exceptions, were prejudiced against reservoirs and gave them but scanty consideration. This was due, no doubt, to the attitude of the majority of the army engineers. That they were not hide-bound in this respect, however, and that their reports have been improperly used as generalizations, is evident from a number of documents of the Corps of Engineers, notably a report by Brigadier General (then Captain) Chittenden in 1897, pointing out the advantages of reservoirs. The decisions at Pittsburgh and Dayton augur more impartial consideration of reservoirs in the future than in the past.

Absurdities in Highway Specifications

IN specifications put out for sixty-four miles of contemplated road-building in St. Johns County, Florida, there are several features that call rather loudly for comment. The three types of pavement specified are asphaltic macadam, cement concrete and vitrified brick. Reading the asphaltic-madacam and cement-concrete portions of the specifications one is inclined to believe that it was never seriously intended to do any work under them; while the brick specification is drawn with sufficient detail to secure the construction of a good pavement.

In the asphaltic-macadam section it is simply stated that a sample of the asphalt proposed to be used must accompany the bid and that all such materials "will be considered in regard to their adhesiveness, effect of water, cohesiveness, ductility, effect of temperature, high percentage of bitumen and injury by heat when melting for use." But what will be the county's requirements in these respects are not in any way indicated.

It is in the section referring to cement-concrete pavements that we come upon the real gem of the specifications. This is as follows: "The quality of workmanship shall be equal to that followed in the best constructed concrete pavements of Wayne County, Michigan, and carried on in such manner as to prevent cracking." This is as bad an example as one can see of the setting up of a standard which is no standard at all. What was the "quality of workmanship" in the best constructed concrete pavements of Wayne County, Michigan, it would be impossible to say; and as all of the Wayne County pavements show a great many cracks, it is difficult to understand how the last phrase of the paragraph quoted could be complied with. Some idea of the number of cracks to be found may be gathered from the report of Frank F. Rogers, highway commissioner of Michigan. According to a table presented by him at the last American Road Congress, in Detroit, Woodward avenue showed 160 cracks in 209 sections; Grand River avenue, 154 cracks in 308 sections; Michigan avenue, 355 cracks in 1570 sections, and River Road, 195 cracks in 434 sections. In each case the sections are 25 ft. in length.

These figures are not given for the purpose of reflecting unfavorably upon Wayne County roads, but only to show how impossible it would be to conform to the St. Johns County requirement that the building of its roads must be "carried on in such manner as to prevent cracking." The uncracked concrete road has not yet been built. How serious an objection this is to the concrete road is another matter.

The drawing of paving specifications has improved very much in recent years, but the one in question and many others that come to notice show that there is still a great deal of room for further improvement.

Sewers for Snow Removal

TO remove five million yards of snow in a month, as against the former season record of two and a half million; to lower the cost to 43 cents a yard, as against a former minimum of 50 cents, and, finally, to work out what promises to be a solution of a very serious problem that has vexed and baffled able predecessors—these are accomplishments of which any new incumbent of public office may well feel proud. Yet, during the recent blizzards which tied up street traffic in New York City the commissioner of street cleaning was the target of the newspaper critics—those omniscient individuals who, in a one-page letter to their morning paper, solve over-night problems which vex the heads of city departments for months. These critics will profit by a careful study of the leading article in this week's issue. It is written by Commissioner John T. Fetherston and is a complete refutation of the absurd charges of dilatoriness and inefficiency which impatient citizens, with no appreciation of the immense task which the storms imposed, leveled at the department's work. Mr. Fetherston's figures speak for themselves. There were eight snowstorms between Feb. 13 and March 17, with a total fall of 34.7 in. On March 19 there had been removed 5,257,562 yd., at a cost of 43 cents per yard. Compare this record with the work of former years. In 1912-13, under the preceding administration, 497,757 yd. were removed at a unit cost of 50 cents, the fall being 11.8 in.; in 1911-12, with a fall of 22.7 in., the quantity was 1,637,593 yd. and the unit cost 55 cents; in 1910-11, with a fall of 24.7 in., the quantity was 2,628,890 and the cost 56 cents, and in 1909-10, with a fall of 30 in., the quantity was 1,873,236 and the cost 75 cents.

One of the most interesting features of the article is the explanation for the low cost this year. It is attributed to the extensive use of sewers for disposal. This practice has always been objected to by officials of sewer departments—from whom permission to use the conduits must be obtained—on the ground that it would clog the lines and flood cellars. It has been proved, by extensive tests this year, however, that under careful supervision and with the use of a stream of water from a hose, snow may be dumped even into small pipe sewers and carried away with no serious consequences. This is an important announcement and promises in conjunction with the organization of a "snow-fighting" force, as it has been called, a solution of the problem of rapid snow removal. By "snow fighting," as the term is here used, is meant a co-operative effort to remove snow *as it falls;* sweeping the clean material into sewer manholes and employing a sufficient force so that work may proceed day and night. One of the most significant statements which Mr. Fetherston makes is that, with the sewers available for the use of the street cleaning department snow can be disposed of at a cost of not more than 10 cents per cubic yard, as against about 50 cents per yard when the method of hauling to dumps with teams is used.

It is interesting also to note that the advent of the motor truck has had an effect on the snow problem, for this year there was a considerable shortage of horse-drawn vehicles for emergency work.

The immensity of the snow problem in New York is apparent when it is learned that the storms of the past few weeks cost, for removal, about $2,500,000 and did damage in New York which, at the lowest estimate is placed at $5,000,000. If the plan of organizing the snow-fighting force and using the sewers is employed on a larger scale hereafter, a repetition of this year's storm record—the concentration of a winter's snow in three weeks—need not be feared.

"Representative Citizens" as Engineering Aides

LAST week there were two important developments in the tangled New York highway situation—one the report by James W. Osborne, the graft investigator, and the other the prompt repudiation by Governor Glynn of one portion of that report, emphasized by his appointment of General Rossell as advisory engineer to the commissioner of highways. While this section of the report is thus dead, it is so typical of the recommendations of laymen regarding the administration of engineering matters that comment is not amiss.

Mr. Osborne's report contained recommendations as to organization that amounted to a prescription of more evil for conditions that are already evil enough. Having found that political, bipartisan and mixed lay and professional administration of the highway department has resulted in scandal, waste and bad work, Mr. Osborne proposed as a cure more of the same sort of administration. He recommended a board of eight representative citizens, selected on partisan lines, to administer the highway funds and broadly supervise the department. It is true that he followed this by another recommendation that the board of eight should have power to appoint an engineer of the highest standing to be the executive and responsible head of the department. If this engineer were to be the real head, question at once arises as to the usefulness of the eight representative citizens who would know nothing about the work to be done and would serve no definite purpose except that of eight nuisances and as many stumbling blocks for the responsible chief.

Commissions the members of which know what they are doing have accomplished good work even in the field of engineering. A commission of citizens, entirely lacking responsibility, information or fixed duties would be about as useful to a chief engineer of highways as would an eight-piece string orchestra. Could they tell the engineer how to organize the department, or how to build roads, or where to build them? If there was a prospect that they would do nothing, it would not be so bad. But precedent strongly inclines to the opinion that the commissioners would simply be so many wire-pullers and collectively an almost insurmountable obstacle to efficient administration.

A close observation of the working of the New York highway department under the Hughes, Dix and Sulzer administrations shows that what is needed is not a commission of any kind or any more divided responsibility; the situation calls for the appointment of just one man who is honest enough and knows enough about organization and engineering to be trusted with the whole job. Such a man could not be controlled by politicians in making appointments, nor could he be unduly influenced, as to types of construction or materials to be used, either by producers of road products or public clamor. Roads can be built just as the Panama Canal was built if the people want them to be built that way. They never will be built rightly by lay commissions. Imagine the Guggenheims employing Pope Yeatman to develop their Chilean copper properties under the supervision of a committee of eight "representative citizens," and there is provided a viewpoint from which even the most enthusiastic believer in democracy in engineering can see how absurd was the Osborne proposal for solving New York's highway problem.

There is no dearth of capable engineers for State or municipal work, as will be proved as soon as States and cities are willing to employ experts on terms that free them from political influences and fear of losing their jobs if the politicians and the newspapers are not kept in good humor.

Daylight Illumination

THE last few years have seen very extensive studies in the theory and practice of artificial illumination, and in the light of present experience it is certainly not only possible but easy to design illumination for a given room so that it shall be satisfactory for any required purpose. The qualifying provision which must be attached to this statement, however, is that the uses of the room shall be established and the working positions known prior to the installation of the lamps. One cannot take a room used and lighted for storage purposes and transform it into a bookkeeping office without changing the lights.

However, while the principles of artificial illumination are fairly well understood, those of natural illumination are known only in a relatively slight degree and need most thorough investigation. Many a building has been erected under the supervision of presumably intelligent architects, only to prove highly unsatisfactory from the lighting standpoint when actually put into use. Conditions with respect to the lighting of a building have changed greatly in comparatively recent years. The evolution of the skyscraper has greatly decreased the available light at the lower levels and the construction of huge industrial buildings has brought with it the serious task of lighting large areas from wholly inadequate lateral surfaces. The introduction of prism glass has helped matters considerably here and there, but even prism glass cannot be successful in bringing good illumination to points toward the center of very large and deep rooms.

A recent investigation has been going on in England concerning the lighting of schoolrooms, which has brought out a very curious mass of information. The most striking point was the great uncertainty introduced in the question by the performance of the eye itself. This organ fortunately works well over a very wide range of brightness or it would hardly be able to work at all. In investigations of British schoolrooms, for example, the light at noon in an unfavorable location ranged from a little over 2 ft.-candles in midwinter to 14 or 15 in midsummer, while at nine or three o'clock the figures were respectively about 1 ft.-candle against a dozen. Similar conditions are found in offices, the range going from 1 or 2 to 15 or 20 ft.-candles. The eye will still work well even at the lower limit if, so to speak, it is coaxed into doing its work by a gradual diminution of light. In one drafting office referred to in the discussion the draftsmen were found habitually to turn on the artificial light only when the natural light had fallen considerably below 1 ft.-candle.

Under modern building conditions the tendency is to produce lower minima and lower maxima in all rooms except those where very unusual window space or skylight lighting is available. In the struggle for economical building construction there is a tendency toward compactness of arrangement, which very frequently stands in the way of even tolerably good lighting, particularly in the lower stories. Indeed the architect's plans for one huge office building were not accepted recently because investigation showed that artificial light would have to be provided for a large part of the tenants most of the time and hence the renting value of the structure would be so seriously damaged that it was thought unwise to go ahead with the construction from the plans proposed.

It is plainly evident that daylight illumination needs as thorough an overhauling just now as artificial lighting did ten years ago. In the latter case very great progress and improvement have been made, in the former relatively very much less in spite of pressing needs from the rapid alteration of conditions. It is time for painstaking study of the theory and practice of illumination from windows in the light of present-day requirements.

Preliminaries to Erecting a Great Bridge

IN this country where the shop fabrication of steel bridges is highly developed, where facility of erection is recognized as an important element of design and where extensive equipment is devoted to the erection of the superstructure, the field work on even very large spans is so rapid that it is generally measured by weeks or months and seldom, except for the very largest spans, involves very remarkable plant or is far removed from the commonplace. In notable contrast to this almost routine work is the erection of the greatest span in the world, preparations for which are described on page 366. Over 60,000 tons of steel are to be assembled in three spans, of a combined length of 2830 ft., 150 ft. above the water. The river is 200 ft. deep, with a tide of 16 ft. and a current of 8 miles. Pieces weighing 185 tons and compound members nearly 300 ft. long, weighing more than 1200 tons, are to be handled in mid-air and assembled and maintained with precision. Two cantilever arms must be built out self-supporting for 580 ft. beyond their piers and remain exposed for months to the severest storms and a 640-ft. double track 5000-ton railroad span must be built at a distance, floated to the site, raised 150 ft. and connected to them with great speed and accuracy.

It is expected that all this can be accomplished in four years of elapsed time, or less than half as much working time, since work must be discontinued during the long and severe winters. To do this, elaborate provision is now being made for all the construction operations, the schedule is prepared for the successive steps and the details of operations are being minutely worked out, instructions prepared and machinery, tools, supplies and every needed facility provided in advance, due regard being had for the utilization of certain parts of the equipment repeatedly to avoid unnecessary duplication. Even with this care the cost of installation of the whole erection equipment will considerably exceed $500,000, exclusive of maintenance, supplies and labor, so that the total erection expense reaches thousands of dollars a day for the actual working time.

The structural steel in the falsework, travelers and yard equipment for temporary work will be about 4,000 tons; two 800-hp. electric power plants and two sets of air compressors will be required; two 1000-ton steel tower-travelers, 200 ft. high, must be erected and equipped, and a massive steel falsework, more than equivalent to permanent railroad viaducts, must be built not only for the temporary support of the permanent trusses, but also for the separate support of the great travelers. Barges and falsework must be built for the 640-ft. span, and special hydraulic apparatus provided for lifting it to place. Provision must also be made for the maintenance of a large force of men at the site.

These are some of the preliminaries involved. A few of them are outlined in this issue and give some idea of the importance of the work.

Removing Snow Banks in Front of Municipal Building

Clearing Streets of a Snowbound City

Recommendation for Use of Sewers for Snow Removal and Organization of a "Snow-Fighting" Force in New York City

By JOHN T. FETHERSTON
M. Am. Soc. C. E.; Commissioner of Street Cleaning, New York City

FOR five weeks the Street Cleaning Department of New York City, supplemented by a large force of contractors' men—the total number amounting to 20,500 men per day—has been engaged in a struggle to open the streets of the city for traffic and to remove the accumulation of snow resulting from eight different storms, two of which were larger than the normal snowfall.

The Weather Bureau statistics regarding the storms are shown in Tables 1 and 2.

Based on Table 1, the average weight of snow per cubic yard for the period in question amounted to 302 lb., which is nearly double the normal density of snow.

The area and mileage of paved streets on the city's schedule for snow removal are shown in Table 3.

Combining the figures of Tables 1, 2 and 3 it will be found that the total amount of snow falling on the scheduled area was 19,351,322 cu. yd., equivalent to 2,922,050 tons. The figures indicate in a small way the problem confronting the department, when it is considered that demands are made for the immediate clearing of streets for traffic and for the immediate removal of snow, without regard to the quantity of work necessary in handling the snow. For comparison with other years, Table 4 provides approximate cost records.

The cost per cubic yard of snow removed for this year is below that of former years, due to the fact that approximately 334,018 cu. yd. of snow were disposed of through the sewers by city forces at a greatly decreased cost as compared with contract work. Tests on snow disposal by city forces using sewers shows a variation between 6 and 8 cents per cubic yard. It will be noted from Table 4 that the fall of snow this year exceeded that of any of the years mentioned, but the most significant fact in connection with this year's snow work was the prevailing low temperature which succeeded the storms, as shown in Table 2. As a matter of fact, very little of the snow was removed by Nature's forces (sun or rain), and the low temperature required not so much the removal of snow as the picking of ice mounds and ice slabs and the removal of ice. Except for the first few days after the snowfall of Feb. 13, nearly all the work of snow removal was changed to ice removal.

TABLE 1.—DEPTH AND WEIGHT OF SNOW

Date	Depth, in.	Density, per cent	Weight per cu. yd., lb.
Feb. 13 and 14........	9.7	20	337.5
Feb. 16...............	5.2	6	101.25
Feb. 17...............	0.1	..	....
Feb. 19...............	0.8	15	253.125
Feb. 23 and 24........	1.1	7	118.125
Mar. 1................	11.0	28	472.5
Mar. 2................	3.5	10	168.75
Mar. 6 and 7..........	3.3	10	168.75
Total	34.7	..	......

TABLE 2.—TEMPERATURES FROM FEB. 14 TO MARCH 18, 1914

Date	Max.	Min.	Mean
February			
14	32	17	24
15	23	12	18
16	24	13	18
17	23	12	18
18	32	22	27
19	34	26	30
20	29	13	21
21	26	10	18
22	36	18	27
23	24	8	16
24	16	1	8
25	24	1	12
26	43	13	28
27	46	27	36
28	46	32	39
March			
1	39	16	27
2	26	24	25
3	40	31	35
4	43	30	36
5	41	30	35
6	38	30	34
7	40	30	35
8	40	24	32
9	34	23	28
10	35	25	30
11	31	17	24
12	34	21	27
13	38	28	33
14	43	28	36
15	56	37	46
16	53	38	45
17	53	34	43
18	45	27	36

Average, 28 deg.

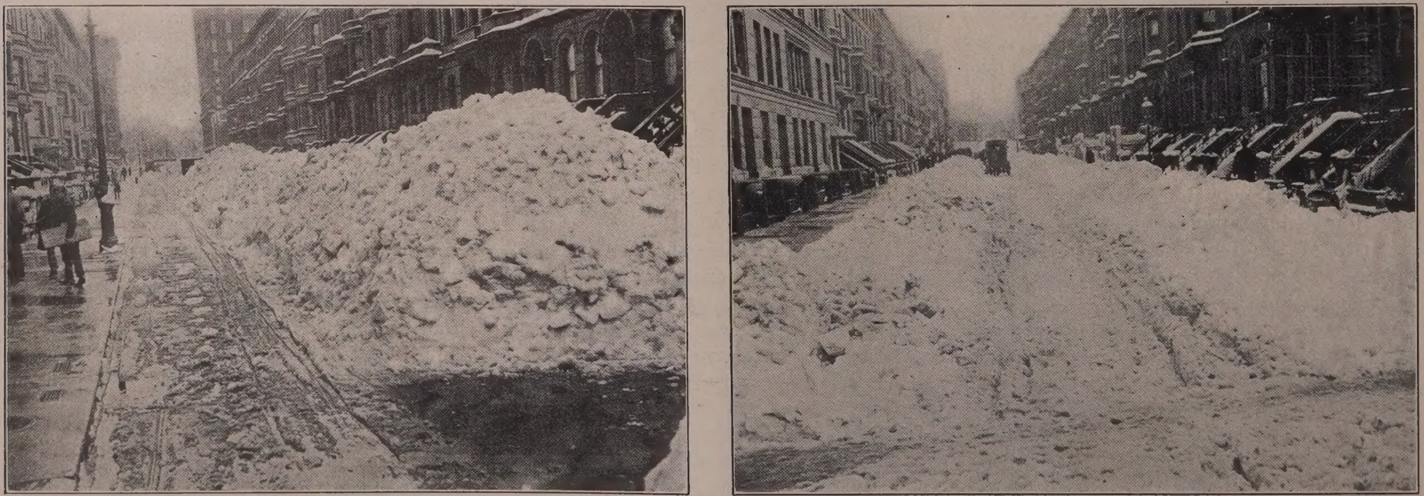
SPEED OF REMOVAL

CONCERNING the speed with which the work was performed, Table 5 is of interest as indicating the rapid progress made in removing the large volumes of snow by comparison with the last big storm of Christmas Day, 1912.

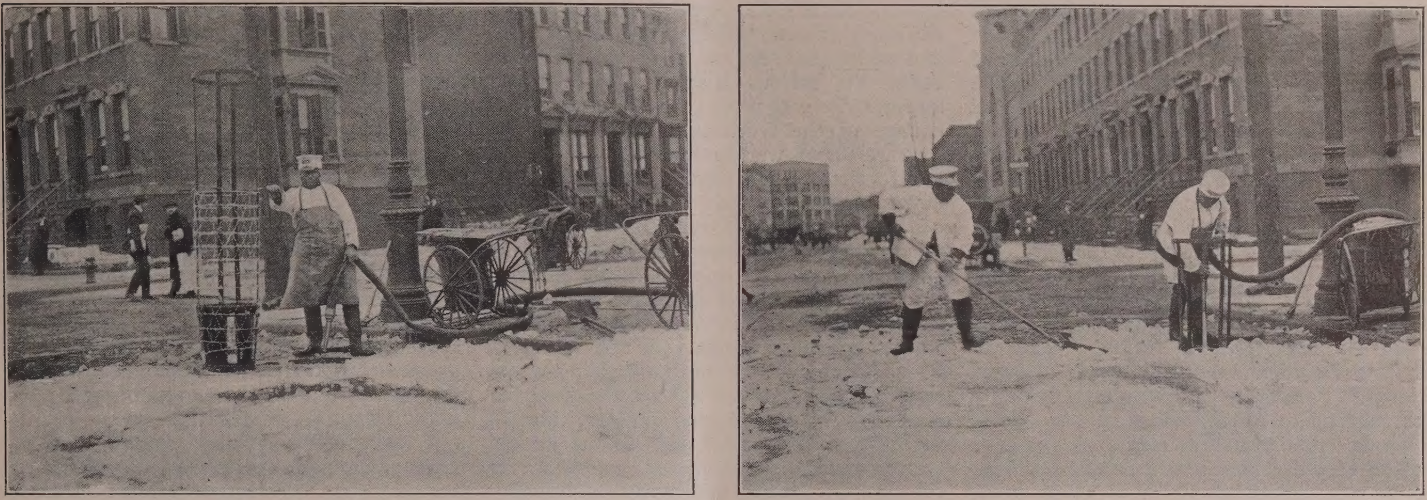
The conclusions in Table 5 show that practically 92 per cent more snow was removed from the streets in 1914 than for a similar period in 1912. Stated in another way, more snow was removed in five days

TABLE 3.—AREAS AND MILEAGE OF PAVED STREETS SCHEDULED FOR SNOW REMOVAL

Borough	Sq. yd.	Miles	Streets not scheduled, miles
Manhattan	11,661,386	331.3	107.7
Brooklyn	6,809,680	193.5	478.9
Bronx	1,605,306	45.7	109.2
Total	20,076,372	570.5	695.8



Two Methods of Piling Snow in Streets—Center Pile at Left and Side Piles at Right



The Solution of New York's Snow Removal Problem—Using Sewers and Water Jets Instead of Carting

from the streets in Manhattan and The Bronx than in eight days following the 1912 storm.

With a given force and equipment the volume of snow removed is the index of the department's efficiency in snow work, though this is not always conceded by citizens demanding instant removal of snow, regardless of the amount of work entailed. The figures in Table 5 speak for themselves with respect to the rapidity of snow-removal work in Manhattan and The Bronx, while equally satisfactory results were obtained in the Borough of Brooklyn. Only the amount of snow removed by the contractors' and city's forces is given in Table 5, and no account is taken of the quantities removed by the street-railway companies.

FORCE OF 20,500 MEN

THE average daily force employed on snow removal between Feb. 14 and March 1 is summarized in Table 6.

In addition to the force tabulated in Table 6 the regular employees of the department brought the total number of men under control of the commissioner of street cleaning up to 20,500, engaged on snow work, refuse collection, stable work, and supervision of street-cleaning activities.

Practically the same force was continued on snow-removal work for four weeks succeeding the first storm on Feb. 13, 1914. During the last week gradual reductions have been made in the number of department emergency employees, and the contractors' forces have likewise been reduced as the scheduled area of snow removal was cleared. On March 20 more than 20,000,000 sq. ft. of pavements have been cleared in the three boroughs of the city, and additional work in removing ice and snow from streets not on the city schedule is still in progress, and will continue under present weather conditions for at least two or three days more.

CONTRACT WORK IN SNOW REMOVAL

DURING July, 1913, contracts were entered into for snow removal from schedules of streets in the boroughs of Manhattan, The Bronx, and Brooklyn, the lowest bidders being as follows: Borough of Manhattan, Belmont Trucking Company, at a cost of 56 cents per cubic yard of snow removed; Bronx Borough, Harold Christiansen, Jr., 42 cents per cubic yard; Borough of Brooklyn, Robertson Construction Company, at a cost of 41.9 cents per cubic yard of snow removed.

According to the terms of the contracts truck or wagon measurements determined the amount of snow removed and formed a basis for contract payments. This necessitated the measuring of more than 3000 trucks by employees attached to the Bureau of Weights and Measures, who affixed to each truck a serial number for identification purposes. The contractor was required to have at least twenty trucks and fifty laborers in each gang. Sixty-four day gangs and ten night gangs were provided in the boroughs of Manhattan and the Bronx, with fifty gangs in Brooklyn.

TABLE 6—AVERAGE DAILY FORCE EMPLOYED ON SNOW REMOVAL FEB. 14 TO MARCH 1

	No. men	Horses	Trucks	Auto trucks
CONTRACTOR'S FORCE				
Foremen	260	....	....	..
Laborers	6,256	....	....	..
Drivers	2,960	5,720	2,860	40
D. S. C. FORCE				
Sweepers	2,900	....	....	..
Extra laborers	3,230	....	....	..
Clerks	60	....	....	..
Officers	195	....	....	..
OTHER FORCES				
Sewers	45	....	....	..
Parks	329	65	43	..
Water Supply	20	....	....	..
Weights and Measures	140	....	....	..
Comptroller's office	30	....	....	..
Total	16,325	5,785	2,903	40

The contract likewise required the maintenance of an elaborate checking system, so that when a truck was fully loaded a triplicate ticket was punched by a loading foreman at the time indicated in a table on the face of the ticket. After dumping the load of snow at a bulkhead or in a sewer, the driver of the empty wagon presented the same ticket to the dump foreman,

TABLE 4—COST OF SNOW REMOVAL PREVIOUS SEASONS —BOROUGHS OF MANHATTAN, BROOKLYN AND BRONX

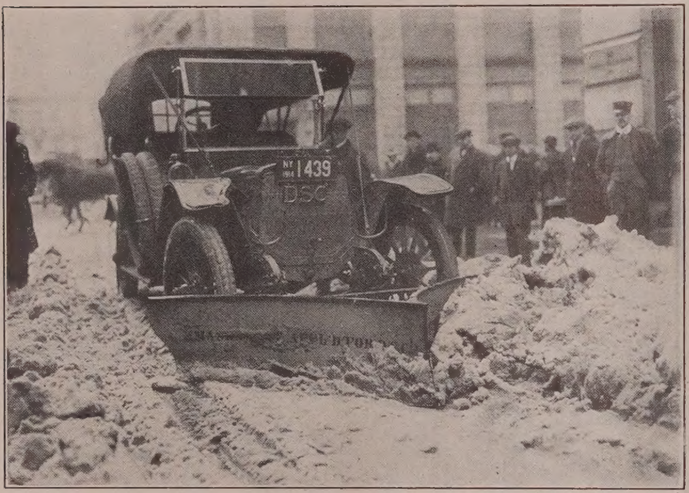
Season	Snowfall, in.	Cu. yd. removed	Total cost	Cost per cu. yd.
1909-10	30.	1,873,236	$1,405,873	$0.75
1910-11	24.7	2,628,890	1,475,985	0.56
1911-12	22.7	1,637,593	893,233	0.55
1912-13	11.8	497,757	249,307	0.50
1913-14	34.7	*5,257,562	*2,248,288	0.43

*From Feb. 14 to March 18 inclusive.

TABLE 5—COMPARISON OF SNOW-REMOVAL WORK IN MANHATTAN AND THE BRONX FOR EIGHT DAYS OF STORM IN DECEMBER, 1912, AND IN FEBRUARY, 1914

	Dec., 1912	Feb., 1914
Depth of snow, inches	11.8	15.8
Number of contractors' laborers	12,998	27,691
Number of D. S. C. emergency laborers	12,281	17,380
Total number of laborers employed	25,279	45,071
Number of trucks employed	7,954	13,090
Number of truck loads hauled	67,367	128,997
Number of cart loads hauled	4,172	9,155
Or equivalent to truck loads hauled	2,086	4,577
Total number of truck loads hauled	69,453	133,574
Approximate cu. yd. of snow hauled	312,538.5	601,083
Av. loads hauled per truck per day	8.7	10.2
Average temperature, deg Fahr.	35	22

Dumping Snow Hauled by Wagon to River Piers who likewise punched the time of departure in a space provided for that purpose on the face of the ticket. Independent checks of the amount of snow delivered where made by members of the inspection division of the Department of Finance. Likewise an entirely separate force of checkers directly under the control of the commissioner of street cleaning visited the various gangs and dumps at irregular intervals during the period of snow removal to observe the operations of the checking system and to note any delinquency on the part of checkers or attempts on the part of drivers to secure inflated returns on the amount of snow removed and delivered at the various dumps. Punches used by loading and dump foremen were changed at least four times per day at irregular intervals, a record made of the changes, and punched tickets later compared with punch exchange cards to control the time of punching.



Snow Plow Attached to Department Automobile

Snow Removal Gang Clearing Columbus Circle

While this portion of the contract carried out the intention of its designers in preventing extortion and dishonest practices, at the same time it caused at least one day's delay in proceeding with the work after the snow had reached a sufficient depth to require the services of the contractors' forces.

Contractors' men in all boroughs co-operated with the Department of Street Cleaning in every regard, and the officers of the various organizations did everything in their power to expedite the work of snow removal. There was a limit, however, to the number of trucks that could be secured, and this prevented the application of a larger force to the clearing of the streets; in fact, the experience of the department and past records indicate that the number of truck owners willing to work on snow has decreased gradually year by year, and auto trucks, which are rapidly replacing horses, have not been secured in sufficient number to make up for the deficiency in trucks. As time goes on indications are that the number of trucks available for snow removal will decrease. This will necessitate securing other means than truck hauling for removal of snow after it is piled.

Sewers for Snow Removal Work

IMMEDIATELY after the first snow started to fall the sweeping and street-cleaning force of the department was doubled, each sweeper bringing with him or being furnished with a helper to clear cross-walks and intersections, open gutters, clear around sewer basins and fire hydrants, and assist generally on snow-removal work. After the serious character of the first storm of Feb. 13 was realized and the inadequacy of the trucking force became apparent, plans were immediately made to secure the use of sewers other than the twenty-eight allowed in the Manhattan contract for the disposal of snow. In previous years permission to use sewers for snow disposal was refused by the various bureaus of sewers on the ground that past experience justified the closing down of sewers for snow removal, as the force engaged on snow work had no regard for the proper maintenance of sewers and filled the conduits with solid matter, resulting in blocking and serious injury to the sewers and damage to the property owners, whose cellars were flooded. However, by arrangement with the engineers in charge of the various sewer bureaus of Manhattan, The Bronx and Brooklyn, plans were made after the first storm this year to place a sewer inspector at each manhole used by department snow gangs, in order that no material might be allowed to fall into the manhole which would block the sewer.

Flow in Pipe Sewers

TESTS had been made on previous occasions to determine the feasibility of using small-pipe sewers, 12 in. in diameter, but there was no general agreement as to whether or not this could be done successfully. It was conceded by the Sewer Bureau officials that with large brick sewers, having a steady flow of sewage of a sufficient depth to carry off snow, such sewers could be used and were approved for snow disposal, but that with small pipe sewers tests had not been so successful. Further trials, however, were arranged in conjunction with the sewer engineers, and finally it appeared that some simple apparatus designed to regulate the flow of sewage and snow, aided by a stream of water from a hydrant, would permit use of the small-pipe sewers and would possibly afford a means for their continued use for fresh snow disposal in the succeeding years. These experiments were quite successful, and by using a wire basket or a can on small pipe sewers, where there was no flow of sewage, snow was disposed of by a hose stream with reasonable rapidity and at decidedly decreased cost over haulage by truck.

Very little snow-removal equipment is now owned by the Department of Street Cleaning, except sixty road scrapers, which are available for use during or immediately after a snowfall. These machines did very good work in clearing the main portion of the principal arteries, but after the first two days they were discarded and not used afterward except to pile slush during a short thaw. No other apparatus for snow removal or snow fighting existed in the Department of Street Cleaning, but it was quite apparent, after sewers were secured for snow disposal, that ordinary pan scrapers used by sweepers and drag scrapers drawn by a single horse would prove advantageous and economical in hauling snow over short distances to sewer manholes, which nominally are about 115 ft. apart. A number of drag scrapers were secured and tests made therewith indicated that snow could be removed at a cost not to exceed 10 cents per cubic yard where sewers were available. This is about one-fifth the amount paid for carting of snow.

Lessons from the Storms

WHILE it is true that the storms during the present year have been the most severe in the history of the department, and that no such conditions have obtained for at least twenty years past, there is no reason to doubt that the same conditions may be expected any year. It will cost the city more than $2,500,000 to remove snow from this year's fall of 34.7 in. The loss to transportation agencies, such as street-railway companies, trucking concerns, and private business houses, cannot be approximated at this time, but it is undoubtedly very large and running into millions of dollars. At the lowest conservative rate it might be estimated that the storms resulted in damage amounting to $5,000,000 to the city during the period of at least two weeks following the first snowfall. Neither the City of New York nor the street-railway companies are properly equipped for rapid snow removal. Every winter practically this condition has been permitted to continue. The use of trucks for hauling snow to bulkheads at the riverfront has never been improved to date. The city has in the past placed most dependence upon cartage of snow from streets to adjacent waters. This year's experience should teach a lesson in preparedness and advance planning, so that a similar condition may not prevail in future.

There are two phases relating to snow

work—snow fighting and snow removal. By the term "snow fighting" is meant an organized effort to remove snow from thoroughfares as the snow falls. At present the city waits until the snowfall is over and traffic congested before it begins to dig itself out. To have every sewer in town available for the disposal of snow as it falls and to secure a sufficient number of men to keep snow moving into the sewers as it falls appear to be the most feasible ways of meeting the snow-removal problem. It has been demonstrated this year that even small-pipe sewers can be used for the removal of snow, and as the maximum rate of snowfall seldom exceeds 1 in. per hour (or approximately 0.1 in. of water per hour) the capacities of the sewers on the whole should not be overcharged by a maximum snowfall. The principal difficulty in snow fighting will be to secure an adequate force of men ready and willing to begin work on the first appearance of snow and to start actually removing the snow not less than one hour after the first flake has fallen, under conditions which indicate that a continued storm might be expected.

The solution of this portion of the problem will undoubtedly involve the organization of the city by blocks, or sections, with a captain or supervisor in charge of each block or street, and the registration of men in blocks or streets available for snow work, either during the day, when not otherwise employed, or at night after the day's work is finished. It is estimated that for the 570 miles of streets scheduled for snow removal a force varying from 20,000 to 40,000 men working continuously for eight hours will put into the sewers an 8-in. snowfall at a cost not to exceed $75,000. To do this same work by carts and trucks after the snow has stopped falling would cost between $300,000 and $400,000 if all the snow had to be removed. Thus, by the use of sewers and the snow-fighting force the most obvious solution of the snow problem is at hand.

Detailed plans for the organization of a snow-fighting division, the registration of all available men, either as paid employees or as volunteers, and the proper management and control of such a force, together with the inspection of sewers for snow disposal, will require not only an adequate planning force—which does not now exist in the department—but an active publicity campaign and an organized effort to interest citizens not only in helping the city during the snow period but likewise for their own comfort, convenience, and pocketbook. If every sewer in the town can be used for snow fighting—and practically every street has a sewer in it—then the snow-removal problem, instead of becoming not only a burden to all concerned but also a positive source of loss to the city and citizens, would take on the nature of a "snow-fighting bee," with everybody a member of the division.

ORGANIZATION AND MANAGEMENT

TO organize and manage such a force will require not only the co-operation of all departments in the city, but likewise strenuous work, not for a period of eight hours, as is usually the case to-day for employees in the Street Cleaning Department, but, as the work is admittedly of an emergency character, all members of the department should be required to work more than eight hours, and should be paid extra wages during the time when snow work is in progress. A bonus system can and should be provided to cover this phase of the work, and with every man in the department given a definite task to perform and being rewarded for the accomplishment of that task within a stated time, an entirely new spirit would be injected into the snow-removal program.

To-day street-cleaning men work from ten to twelve hours on snow and receive not only no financial recognition for the extra time spent upon the work but are held up by the press as objects of derision. By proper advance planning and intensive studies of all facilities available for snow fighting and the adoption of the best methods, not for the city as a whole, but for each particular district of the city, according to local peculiarities, there is little doubt that more rapid and economical work can be accomplished, especially if a reward system is made a consistent part of the plan.

It is not intended to neglect, however, the present snow-removal methods, as contracts should still be made for the employment of teams and men to remove snow after the storm is over, in the event that the snow-fighting forces have been unable to cope with the situation.

Steel Derrick at New York Equitable Building Falls

Allows Steel Column to Crash Through Contractor's Shack, Killing One Man and Injuring Three Others

ONE of the large steel guy derricks used for the erection of the 30,000-ton framework of the 40-story Equitable Building on Broadway, New York, fell on March 20 and killed one man and injured three others. No explanation has so far been made for the accident, which occurred during the busy afternoon hours, when Broadway, adjacent to the building, was crowded with pedestrians and vehicles.

Although the fallen derrick projected far over the street, it was held some distance above the traffic by the beams and girders already erected in the building and did not directly injure any person not connected with the work. A comparatively light steel column, which had been hoisted to position and was supported by the derrick while being fitted to place, toppled over as the derrick fell and crashed through the contractor's light portable office building, where the injured men, all of them employed on the building, were.

DETAILS OF DERRICK

THE derrick was one of six duplicate standard steel derricks which had been in service only about three years, and at the time of the accident was installed on the second floor girders of the building about 20 ft. above the street and was erecting the third tier of columns for the second and third stories. It had previously hoisted and erected there 32-ton columns, some of them much heavier and in more difficult positions than the one which fell with it. The column which fell was about 30 ft. long and weighed 13 tons; it had already been erected in position and was being held in place by the derrick when the latter fell. The column, being without bracing, tipped over, revolving about the lower end and fell on the temporary bridge constructed to protect the Broadway sidewalk.

This bridge was similar to those ordinarily used for this purpose, except that it chanced to be doubled; the original bridge constructed by the contractor for the foundation work had been inclosed by a second bridge constructed by the contractor for the steel superstructure. Both of them were very heavy wooden platforms intended to carry safely a load of 500 lb. or more per square foot. The upper one was floored with 3-in. planks supported on 12 x 12-in. transverse beams about 10 ft. long and 10 ft. apart. The column broke through this platform and was arrested by the similar platform just below it.

The derrick had a mast 76 ft. long and a boom 65 ft. long. It was guyed with eight 1¼-in. plow-steel cables, each having a rated ultimate strength of 140,000 lb., and secured to the steel columns and girders already erected by heavy chains which, at the beginning of the work, had been annealed and tested to insure their strength. The derrick had been in operation on this building about two months and was inspected not only when it was placed there but also when it had been received at the storehouse after completing the last job previously. The derrick had a capacity for a 30-ton load under the most unfavorable circumstances and was considered abundantly strong for a 40-ton load in the position of the column which fell, about 50 ft. from the mast.

CAUSE OF ACCIDENT

AS no other initial cause for the accident has been shown, it has been suggested that it may have been due to the breaking of one of the guy lines, which might cause such an accident and would not be incompatible with the gradual fall of the mast which occurred. Neither the boom tackle, the hoisting tackle nor the attachment to the column failed. The mast was bent by falling across a girder, but can easily be repaired, and the boom was uninjured. No report of an investigation of the derrick and its fittings is yet available.

This derrick, together with five others in the set, had already handled about 6000 tons of the steel framework in the lower portion of the Equitable Building and had previously erected all of the 25,000 tons of steel in the framework of the Municipal Building for which they were first used, and the 24,000 tons of steel in the Woolworth Building, including 30-ton pieces, which was erected in about seven months. No accident had occurred to any of the derricks in either of these jobs.

Federal League Grandstand at Chicago

PLANS for the Federal League baseball grandstand in Chicago have been completed. The stand is of reinforced concrete, similar in most respects structurally to the White Sox stand in Chicago, described in the Engineering Record of Sept. 3, 1910, page 260, except that now only a single-deck will be built with a steel roof having a 25-ft. cantilever overhang to be removed when the second deck is needed. Provision is made by double columns and beams for expansion and construction every three to four bays, which are 18 ft. 9 in. long. Of these there are twenty-one on the curve, twelve on the left of the field and thirteen on the right. Home plate is 72 ft. from the building line, and the angle of divergence is 118 deg. Thirty-two rows of seats are provided for and four incline entrances. Zachary Davis is the architect, and the structural plans were prepared by E. C. & R. M. Shankland.

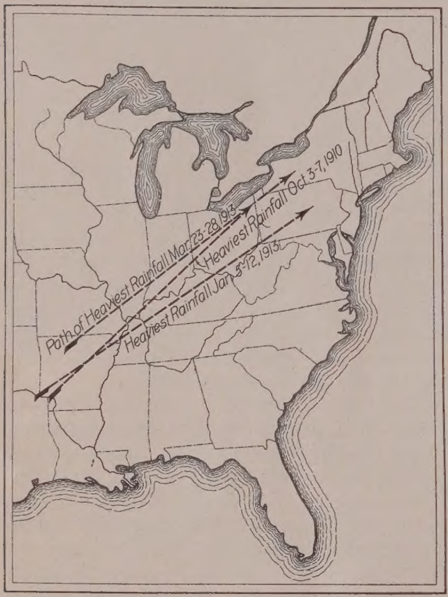
Present Status of Flood-Prevention Studies at Dayton

Résumé of the Work Done Since the 1913 Flood and an Outline of the Retention-Basin Scheme Proposed

FLOOD-PREVENTION history and precedent, it seemed, were to be made and set in Dayton last week through the hearings for the formation of the Miami Conservancy District. The court decided, however, that it would hear arguments on the constitutionality of the act and the question of jurisdiction on March 31, so that it is unlikely that expert testimony will be offered until the latter part of April, and then only if the constitutionality of the law is established.

Within the year following the disaster a prodigious amount of work has been done, and it is proposed here to review it briefly and to sketch the plans proposed.

The flood was at its height on March 25, 1913. On May 5 the Morgan Engineering Company was engaged to take charge of the flood prevention work, and by the middle of May sixty engineers were at work, making hydraulic studies and conducting surveys in the watershed. On Oct. 1 a preliminary report of the plans was made (see Engineering Record of Oct. 11, 1913, page 399), and on Jan. 17 the advisory board, consisting of D. W. Mead, J. W. Alvord and S. M. Woodward, passed on the plans so far as made, endorsing their adequacy (see Engineering Record of Jan. 31, 1914, page 132).


Path of Heaviest Rainfall Mar. 23-28, 1913
Heaviest Rainfall Oct. 3-7, 1910
Heaviest Rainfall Jan. 5-12, 1913

Paths of Three Heavy Rainstorms

LEGAL ASPECTS AND LOCAL OPPOSITION

SIMULTANEOUSLY another and no less important work was under way. It had been found that economical construction was not feasible under existing laws and, therefore, the securing of new legislation was determined upon. As a result, the Ohio Conservancy Act was drafted and passed, the measure being signed by the Governor on Feb. 17, 1914. The following day a petition was duly filed praying for the inclusion of the counties of Logan, Shelby, Miami, Clark, Montgomery, Preble, Greene, Butler, Warren and Hamilton in the Miami Conservancy District—a "Miamigenossenschaft," to paraphrase the German forerunner of the Ohio plan. It is on this petition that hearings were to have been held in Dayton last week.

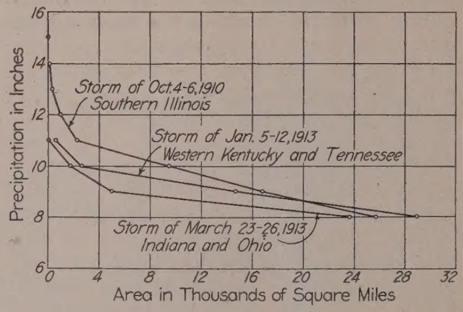
For the judicial procedure a great array of legal and engineering talent had been assembled. Retained by the Dayton Flood Committee, which is backing the Miami Conservancy District plan, and which engaged the Morgan Engineering Company, are Brig.-Gen. O. H. Ernst, Corps of Engineers, U. S. A., retired, selected by his fellow-members as chairman of the board of consulting engineers; Brig.-Gen. H. M. Chittenden, Corps of Engineers, U. S. A., retired; Col. J. A. Ockerson, member of the Mississippi River Commission; D. W. Mead, consulting engineer and professor of hydraulic engineering, University of Wisconsin; J. H. Fuertes, consulting engineer, of New York; Morris Knowles, consulting engineer and former member of the Pittsburgh Flood Commission; T. W. Jaycox, consulting engineer, of Denver; Prof. S. M. Woodward, of the University of Iowa; J. W. Alvord, consulting engineer, of Chicago; C. H. Miller, of the Miller Engineering Company, of Little Rock, Ark.; W. A. O'Brien, chief engineer, Little River Drainage District, Cape Girardeau, Mo.

Aside from the legal and engineering problems there has been another difficulty that at times has overshadowed the other aspects of the case. Misunderstanding and misrepresentation of the plans proposed have been widespread in the upper part of the valley, resulting in opposition of the most unreasonable sort to the flood committee's plans. To meet this opposition an educational campaign has been conducted by the flood committee, illustrated lectures have been given, and meetings at which objections have been met have been held. As a result, while much opposition still remains, many, reasonably inclined, have admitted that they were misinformed and have ceased their opposition.

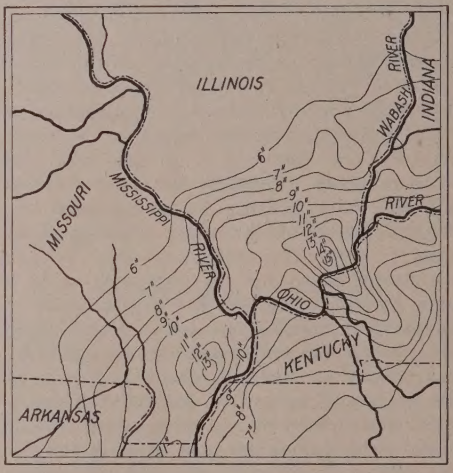
HYDRAULIC STUDIES

HYDRAULIC studies made by the Morgan Engineering Company have been both more extensive and intensive than any heretofore made in this country or abroad on a single project. Naturally the hydraulics of the basin under consideration have been most thoroughly studied; its rainfall and runoff have been determined so far as records were available or evidence could be found in the valley, while topography and stream cross-sections have been obtained by an extensive field force. Moreover, the rainfall records of the U. S. Weather Bureau have been searched for data on storms anywhere, except in the arid regions, where 10 per cent of the average annual precipitation has occurred in one day or 15 per cent in one storm. As a result the tabulated information on this head is more complete than any previously in existence. European literature in both German and French has been gone into, and about 700 pages of translations and tables having interest or value in connection with the present studies are available. In the judgment of the Morgan Engineering Company not nearly so much experience as might be expected is available in either French or German regarding flood protection that is of value in solving American problems. In other words, American engineers have gone about as far as those abroad in the fundamental hydraulic studies and their application to flood prevention.

The information gathered and the deductions therefrom are naturally too extensive for record here. Two facts, however, are especially worth recording and are represented in accompanying diagrams. The first is the determination of the path of three very severe storms and the intensity along those paths. As will be seen from the first of these diagrams, the paths of three storms—in October, 1910, January, 1913, and March, 1913—are practically parallel and follow up the Ohio Valley and thence over the St. Lawrence Valley. Naturally, therefore, storms originating in Texas, Arkansas and Missouri are of special importance to the Miami watershed.



Magnitude of Three Severe Storms in Eastern and Central States



Maximum Intensities, Storm of October, 1910

The second diagram shows the centers of the heaviest rainfall of October, 1910. The curves pass through points of equal rainfall for a three-day period. In this storm an average of approximately 13 in. fell in three days, while only 9 in. fell in five days on the Miami watershed of March of last year. If the storm center, instead of being in Southern Illinois had been in the Miami Valley, there would have been 30 ft. of water in the streets of Dayton, instead of the 16 on March 25 of last year. Furthermore, since there is no apparent reason why the bulk of this rainfall should not have been dropped anywhere in the storm's path, such a rainfall is to be expected in the valley, and the protective measures must be designed therefor. Accordingly, the measures proposed by the Morgan Engineering Company provide for a precipitation over the Miami watershed in excess of that deposited by the 1910 storm over Southern Illinois.

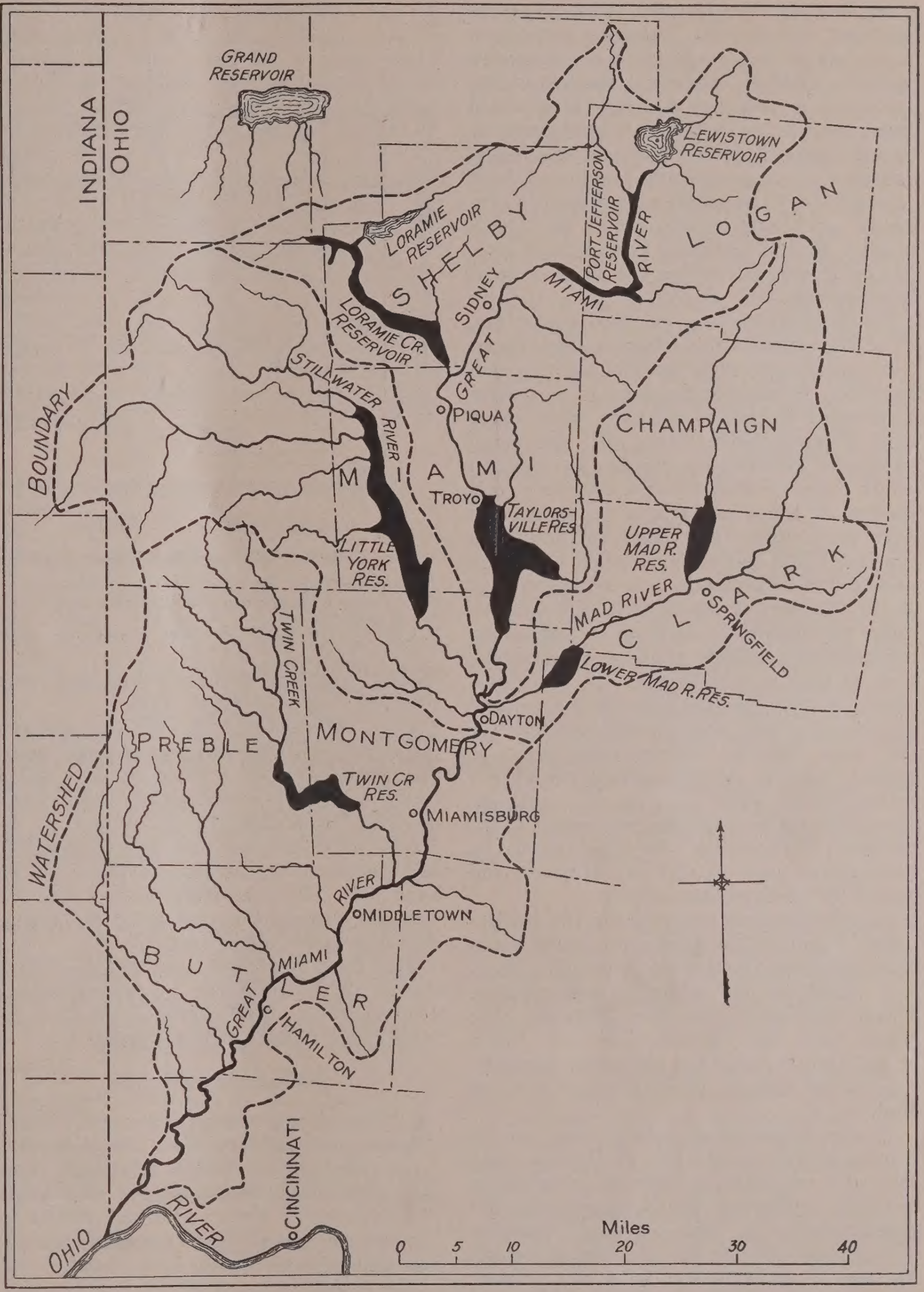
Many other interesting facts have been established. Among the data quoted in a recent exposition of the plans is the record of a rain in southern Iowa that reached from 8 to 12 in. in twelve hours. This storm, covering only about 143 sq. miles of drainage area, created a flow equal to one-third of that coming from the 2500 sq. miles of the Miami Valley at Dayton last March. Rains of 5 to 7 in. in a day over considerable areas have occurred in Ohio, and in Dayton there is a record (in 1886) of 4½ in. in two hours. Another very remarkable rainfall was disclosed in one of the arid regions, at Montell, Tex. Although the average annual rainfall there is about 20 in., 22 in. fell in twenty-four hours in July, 1913. There seems to be no regularity to the paths or the frequency of such local rains. They are purely a matter of chance and are an ever present possibility.

COMPARISON WITH FOREIGN FLOODS

An extensive examination of European literature showed that rates of runoff such as occurred in the Great Miami River Valley in the flood of March, 1913, are not frequent, but have occurred in certain parts of Europe. In parts of France and Germany, where the topography, permeability of surface, annual rainfall, and character of storms are comparable to those of southwestern Ohio, records of flood rates practically as great as ours have been found; while in mountainous regions having steep slopes and impermeable surface, even greater rates seem to have occurred. Table 1 gives a few of the maximum records obtained by Kenneth Grant in his European investigations, together with a few taken from Kuichling's summary published in the December, 1913, "Proceedings" of the American Society of Civil Engineers.

TABLE 1—MAXIMUM RUNOFF RECORDS FOR SOME FOREIGN STREAMS

Streams and Locality	Drainage area, sq. miles	Discharge, sec.-ft. per sq. mile	Date of flood
Durance—Mirabeau, France.	4150	57	1886
Ardeche—Junction with Rhone, France	831	382	1827
Bober—Hammerwerk	793	85	1897
Buech—Junction with Durance, France	552	85	1843
Bober—Mauer, Silesia, Germany	467	91	1897
Queis—At mouth	389	109	1897
Ubaye—Junction with Durance, France	360	127	1843
Coulon—Junction with Durance, France	350	100	1843
Ardeche—Vans, France	215	526	1890
Bober—Rohrlach, Germany	205	160	1897
Queis—Lauban, Germany	187	161	1897
Ardeche—Aubenas, France	178	694	1890
Queis—Marklissa, Germany	118	233	1897
Borgaglino—Genoa, Italy	36	485	1892
Borgaglino, Genoa, Italy	36	421	1908
Eyoch, Balingen, Wurtenberg	35	356	1895
Goldbach, Ornoldsdorf, Germany	20	269	1903



Great Miami River Watershed, Showing Proposed Reservoirs

The conservancy district, so far as assessments are concerned, will cover only those portions of the valley which will receive betterments from the flood-prevention plans. A diagram of the watershed, showing the locations of the flood retention basins proposed, is shown herewith.

While originally the scheme of investigation and flood protection was laid out solely with reference to Dayton, it was soon found advisable to extend them to include the entire valley. It has been the aim of the Flood Prevention Committee and its engineers to investigate every possible method of flood protection in order to be assured that no reasonable possibilities are overlooked. It was the original expectation of the Morgan Engineering Company and the board of consulting engineers (original board) that the most practicable plans for flood protection would probably consist of local channel improvements and collateral protection work.

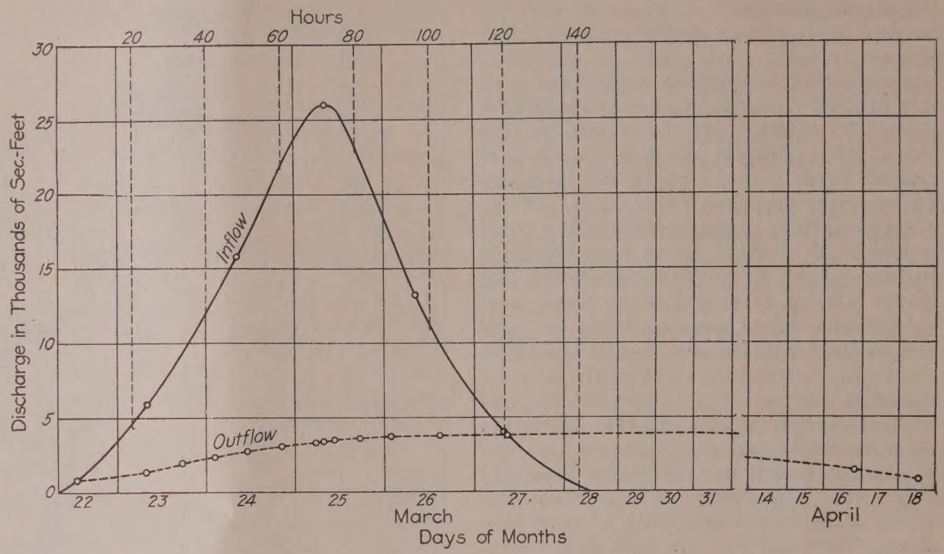
After a brief examination it became evident that local improvements for the protection of each city in the valley would involve so great an expense as to render such improvements financially impossible for many

TABLE 2—CAPACITIES OF PROPOSED RESERVOIRS ON MIAMI WATERSHED

Reservoir	Catchment area, sq. miles	Storage, billion cu. ft.	Storage in 1000 acre-ft.	Storage in. of rainfall	Elev. of spillway	Area submerged at spillway elev., in 1000 acres	Outlet tunnels	Max. discharge of tunnels	Elev. of bottom of rivers	Elev. of top of dam	Max. height of dam	Capacity of spillway sec.-ft.
Port Jefferson	440	0.995	22.8	1.0	980	2.67	....	12,000	945	995	50	35,000
Loramie Creek	240	4.06	93.2	7.3	940	4.90	1-10 x 10	4,150	885	955	70	25,000
Taylorsville	*1120	10.50	241.1	4.0	820	12.16	3-15 x 20	39,600	765	835	70	125,000
Little York	620	17.80	408.8	12.4	885	9.30	1-10 x 10	5,200	770	900	130	85,000
Twin Creek	280	5.23	120.0	8.0	820	3.64	1-10 x 10	4,800	730	835	105	65,000
Upper Mad River	†290	5.87	134.8	8.7	950	6.20	approx. 1-10-14	5,000	895	965	70	45,000
Lower Mad River	630	3.10	71.2	2.1	820	4.50	1-15 x 20	10,000	780	835	55	75,000

*Includes area above Port Jefferson and Loramie Creek reservoirs. Taylorsville and Loramie Creek reservoirs together will hold 5.6 in. from the 1120 sq. miles.

†Two Mad River reservoirs will hold 6.1 in. from the 630 sq. miles.



Effect of Proposed Upper Mad River Reservoir on Storm of March, 1913

Run-off = 90 per cent of rainfall, distributed as shown on inflow curve. Water at highest stage would have been 5 ft. below top of spillway and 20 ft. below top of dam. Amount of water stored during storm = 4,470,000,000 cu. ft. Space still available for storage within reservoir below top of the spillway = 1,400,000,000 cu. ft. or about 24 per cent of capacity of reservoir unused.

of the smaller communities. It also became apparent that for the economic protection of the entire valley a system of reservoirs could be made an important feature of the protection works, that their adoption would greatly reduce the cost of local improvements to individual cities and towns of the valley, and that a comprehensive system of flood protection for the entire valley could be installed at a cost which would be only a fraction of the combined cost of such protection if carried out on the lines of local improvement.

By a general scheme of flood protection, all of the cities in the Miami valley can secure protection most economically by cooperation in the construction of a system of storage reservoirs together with minor local channel betterments; and the small cities like Miamisburg can by this method attain complete security at a moderate cost, whereas if their own efforts for protection were relied upon their condition would be hopeless. The agricultural lands would receive complete protection except in times of floods like that of last March, and in such times the overflow would be a temporary inconvenience rather than a catastrophe, such as that of last March. It, therefore, became evident that the passage of a general conservancy law, which would provide for and make possible the organization of a general district for the protection of the entire Miami Valley, as far as it may be affected by flood conditions, was essential for the relief of the valley. For this reason the Conservancy Law of Ohio was prepared and passed by the Legislature.

In investigating projects for the protection of the city of Dayton a number of plans originally suggested have been considered and found to be entirely impracticable. These included plans for diverting the Miami and Mad Rivers into the Little Miami and several other plans for the diversion of the Miami, the Stillwater and the Mad.

It was found that without the use of storage reservoirs the city of Dayton alone could be protected by several alternative methods, involving the enlargement and straightening of the present channels through the city, or the digging of cutoffs for use in combination with the present channel; but the preliminary estimates showed that the cost of these various projects varied between $30,000,000 and $20,000,000, and none could be found that would cost less than the latter sum.

It is anticipated that only in very rare instances, if ever, will the storage basins be completely filled. They are designed to retain a much larger flood than that which occurred in March, 1913; in fact, if the reservoirs as planned had been in operation last March the one at Taylorsville would not have been over one-third full. This is a necessary precaution following from what was said above about rainfall.

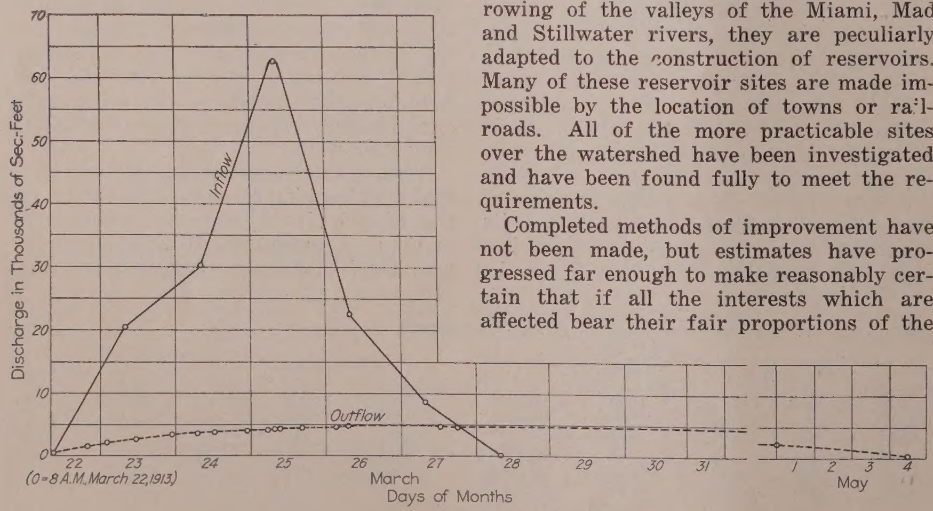
The total drainage area of the Miami River above Hamilton is approximately 3540 sq. miles. The reservoirs shown in the table control about 2650 sq. miles.

Storage Reservoirs

At the time investigations were begun it was not believed that complete flood protection could be secured by storage reservoirs, and the investigation of this means of river control was carried out chiefly because it was the policy to examine carefully every possible method of improvement.

The investigation of all possible reservoir sites was assigned to Gaylord C. Cummin, now city engineer of Dayton. It was found that, due to the alternate widening and narrowing of the valleys of the Miami, Mad and Stillwater rivers, they are peculiarly adapted to the construction of reservoirs. Many of these reservoir sites are made impossible by the location of towns or railroads. All of the more practicable sites over the watershed have been investigated and have been found fully to meet the requirements.

Completed methods of improvement have not been made, but estimates have progressed far enough to make reasonably certain that if all the interests which are affected bear their fair proportions of the cost, flood protection for the Miami Valley can be secured by a system of storage reservoirs more cheaply and more quickly than by any other method. A system of such reservoirs has been outlined which will give complete relief from floods to the entire Miami Valley from near the headwaters of the Miami River to the Ohio River, to the Stillwater Valley from West Milton to its outlet, and to the town of Osborn on the Mad River.



Effect of Proposed Little York Reservoir on Storm of March, 1913

Inflow = 90 per cent of rainfall; no allowance made for retarding effect. Amount of water stored during storm = 10,800,000,000 cu. ft. Space still available for storage within reservoir below top of spillway = 7,000,000,000 cu. ft. or about 40 per cent of capacity of reservoir unused. Water at highest stage would have been 20 ft. below the top of the spillway and 35 ft. below top of dam.

Cost of Reservoir System

The biggest item of cost in the system of storage reservoirs will be the land taken. As the reservoirs will be empty during the crop-growing season of each year, and as the ponding of the water during floods would tend to prevent soil erosion and cause fertile mud to be deposited, the productive value of the lands within the reservoir will probably be increased. However, as it may be necessary to purchase a large part of these lands in securing rights-of-way, liberal estimates of costs have been included of the lands below the water line during the most extreme floods. A large part of the lands in the reservoirs would not be covered once in twenty years.

A system of reservoirs, the sole object of which would be complete flood prevention in the Miami Valley, would cost about $17,000,000. It is possible that a complete detailed estimate will show considerable less cost, but such a possibility cannot be counted upon at present.

In designing these reservoirs it seems desirable to the engineers not to adhere too closely to economic engineering practice in the construction of dams. The life and property interest involved are so great that it is desirable to plan dams of heavier, larger and consequently safer section than is usual. The cross-sections proposed may be criticised by engineers as unduly large and expensive, but under these circumstances it seems necessary that there should be left no room for doubt as to the absolute and complete security of the system proposed. The material available in the valley is suitable for earth dams, consisting of glacial till—a very uniform mixture of clay, sand and gravel.

To protect the entire valley by means of reservoirs will require about half as much time as to protect Dayton alone by local works. It is estimated that from two to three years would be necessary to complete the construction of a reservoir system, after the legal proceedings make construction possible.

Table 2 gives the capacities of the reservoirs proposed, and two of the diagrams show the effect of these reservoirs upon a flood similar to that of March, 1913.

DAMS

ALL dams proposed are to be constructed of earth, with concrete spillways and concrete outlet tunnels. These dams vary from 55 to 57 ft. in maximum height, except the Stillwater reservoir dam, which will probably be 125 ft. high at the river channel. In all cases it is planned to build these dams 25 ft. wide on top, with 4 to 1 slopes on each side. Interlocking sheet piling will be used where needed. The discharge tunnels will be located either through the base of the dams or through the rock of the adjoining hills, and will be of such capacity as to allow the maximum flood expected to fill each reservoir to the spillway crest. It is not planned to make any tunnel larger than 15 to 20 ft. in diameter. More than one tunnel will be used where necessary. No gates of any kind will be used in them unless it be in extra tunnels used only during construction. If tunnels are built in earth, at intervals along them, reinforced concrete collars will be constructed, projecting several feet into the surrounding earth, to prevent seepage along the barrel. The tunnels will be carried several hundred feet upstream from the face of the dam, and the upper sides, as well as the ends, will be left open, except for protective gratings. In addition to this a row of massive concrete pillars will be placed in a semicircle above the outlet to guard against large drift.

At one end of each dam a spillway will be constructed through the point of the hill adjacent thereto; the crest of the spillway will be 15 ft. below the top of the earth dam. The capacity of the spillway will be such as to pass the entire flood discharge of last March at that particular point with a head above the spillway crest of 5 ft. In most cases it will be possible to have the discharge channel below the spillway in rock, and in other cases the discharge channel will be paved with reinforced concrete.

The maximum discharge from each reservoir is naturally regulated to correspond with the safe carrying capacity of the immediate channel below and of the main channel of the Miami through the cities and villages. The safe carrying capacity of the latter through the city of Dayton is 80,000 sec.-ft., to an elevation 3 ft. below the top of the levees, or about 6 ft. above bank level, whereas the flow past Dayton at the height of the flood last year was estimated at 250,000 sec. ft.

COST COMPARED WITH DAMAGES

THE cost as above noted is $17,000,000. Compared with the damages from floods, it is worth noting that in the entire valley last year 400 lives were lost and property damages amounted to about $150,000,000. Moreover, between thirty and forty persons in Dayton alone became demented during the flood, and about as many as perished in the flood itself in Dayton have since died from the effects of exposure. This is not surprising when it is remembered that these people spent two days and two nights on housetops and in trees, with rain falling and a temperature low enough at times to bring snow.

Added to this must be a very large amount of damage, not estimated however, from the nine previously recorded floods—which put water into the streets of Dayton.

Channel improvement measures, affording a substitute for the reservoir system, and consisting of levees and enlargement of cross-section, are estimated to cost for the entire valley between $75,000,000 and $100,000,000.

All of the work has been under the jurisdiction of the Morgan Engineering Company, of Memphis, Tenn., of which Arthur E. Morgan is president and L. L. Hidinger, vice-president.

Recommendations Adopted at Railway Convention

Summary of Action Taken by the Association on the Definite Conclusions of the Various Standing and Special Committees

FOLLOWING the custom of previous years, the American Railway Engineering Association, at its annual convention in Chicago last week, discussed the findings of the various committees and voted upon the recommendations. The review of the year's work, in last week's issue, page 337, set forth these findings, and the action of the association thereon is summarized in the following notes.

TRACK

Roadway.—Six rules governing tunnel construction, three diagrams with explanations indicating typical methods and an outline of two methods of tunnel ventilation in vogue in America were adopted, substantially as recommended by the committee.

Ballast.—Additions were made to the existing rules pertaining to the cleaning of ballast. The new rules recognize the great economy obtainable from screens as compared with forks. They also go more specifically into the details of ballast cleaning desirable.

Rail.—Further revision of the specifications for carbon steel rails was adopted, as were Form MW408 as revised for reporting rail failures, and the four-hole and six-hole drilling proposed for rail joints.

Track.—Typical plans of Nos. 8, 11 and 16 crossovers were adopted, the corresponding main-line turnout plans being accepted last year. The association also adopted the five diagrams of speeds of trains through curves and level turnouts and the table embodying certain of the information in another form. The report itself on this subject, abstracted in last week's issue of this journal, page 328, where four of the diagrams are also presented, was received as information, as was other matter submitted by the committee.

STRUCTURES

Buildings.—The four-page report on roofing was adopted, this to be substituted in the "Manual" for the abstract which the committee was authorized last year to make of the voluminous report submitted at that time.

With certain minor modifications the five-page report on design of inbound and outbound freight houses was also adopted. Nine pages on shop floors, intended to supplement the matter presented last year on freight-house floors, was received as information only by the vote of the association.

Wooden Bridges and Trestles.—The two conclusions relative to inner guard rails were accepted. As the rules now stand, such guard rails are virtually specified on all bridges except solid-floor structures less than 20 ft. long, or on branch lines where the speed is limited to 20 miles per hour.

Iron and Steel Structures.—The one revision and the two additional rules covering the inspection of the fabrication of steel bridges were adopted. The conclusions relative to the protection of traffic at movable bridges were referred back to the committee for further study.

Masonry.—Five of the six conclusions on the subject of waterproofing, given in last week's issue, page 331, were accepted. The second one, relating to membrane waterproofing, was referred back to the committee.

With minor alterations the four conclusions pertaining to disintegration of concrete and corrosion of reinforcing metal were accepted.

Signs, Fences and Crossings.—The standard wooden highway grade-crossing sign was accepted with the elimination of some of the lettering, and the proviso that reinforced concrete might be used for the post. The concrete-and-metal trespass sign was also adopted.

Signals and Interlocking.—The revised signal-and-interlocking symbols, conforming to those of the Railway Signal Association, were adopted.

MISCELLANEOUS

Records and Accounts.—Revision of the "Manual" as proposed was voted. The findings as to subdivisions of Interstate Commerce Commission classification account No. 6 were referred back to the committee.

Various improvements in the conventional signs for maps and plans were suggested, and the committee was empowered to make such changes as it might see fit in the symbols presented at the convention and incorporate its final results in the "Manual."

Rules and Organization.—Revisions were voted in several of the rules governing maintenance-of-way employees, their purport being chiefly a recognition of the safety movement. General rules were adopted for the construction department, as well as more specific rules pertaining to its organization and rules governing chiefs of party and resident engineers.

Wood Preservation.—The first conclusion of the committee relative to the use of refined coal tar—that wherever possible only grade 1 coal-tar creosote should be used, and that coal tar should not under any circumstances be added to creosote of this grade—was adopted. The second, which, recognizing the scarcity of grade 1 creosote and the likelihood of companies using the inferior grades, was intended to safeguard such practices as far as possible by certain restrictions, was accepted as information only.

The recommended methods of accurately determining the absorption of creosote oil were adopted.

Electricity.—The five typical overhead clearance diagrams recommended were adopted.

Uniform General Contract Forms.—The convention adopted the proposal form submitted, and also approved a minor insertion in the indemnity clause of the general contract.

Steel Penstock Collapses

Careless Operator Drains Pipe While Air Vents Are Sealed with Ice, Producing Vacuum

WHILE the vent pipes on one of the 9-ft. steel penstocks of the Connecticut Power Company's hydroelectric plant at Falls Village were sealed with ice a careless operator, disobeying instructions, emptied the pipe line to repair a waterwheel on Feb. 26, with the result that sufficient vacuum was produced to cause the collapse of the pipe. Seven plates on the under side of the pipe near the head block were drawn inward on the vertical diameter to within 15 in. of the top of the pipe and a circular seam on the lower half of the circumference was opened up at about the middle of the collapsed section.

ICE SEALS AIR VENTS

THE sequence of events leading up to this failure was as follows: The weather had been exceptionally cold, the mercury falling to zero, or below, every day for several days before the accident happened. On the morning of the accident the temperature was 14 deg. below zero, and as wheel 1 had been out of service with water standing in the penstock, it is probable that the concrete head block became sufficiently chilled to permit of the formation of ice, thereby completely sealing the vent.

At about noon on February 26 it was decided to drain penstock 1 for the purpose of working on the waterwheel. The operator whose duty it was to operate the head gates was told to close the gate on the penstock, and notwithstanding repeated orders given him to always look for ice in the vent pipes, he disobeyed instructions, with the result that in emptying the penstock sufficient vacuum was formed to cause its collapse.

HYDRAULIC EQUIPMENT

THE hydraulic equipment of the plant consists of three 5000-hp Wellman-Seaver-Morgan horizontal double-runner wheels with wicket gates, the wheels discharging through a draft tube centrally located. The water supply to these wheels is taken from a canal 1800 ft. long lined with reinforced concrete, the forebay being about 375 ft. from the power-station building. The normal water level in the canal is 78 ft. above the center of wheels, and the average net head under which the plant operates is 90 ft. Each wheel is supplied with water through a separate penstock made up of steel plates 5/16 in. in thickness at the upper end and increasing to 7/16 in. at the lower end.

All penstocks are controlled by wooden gates at the forebay with worm and gear control, the larger penstocks being provided with vent pipes 20 in. in diameter located in the concrete head blocks directly back of the head gates. The tops of the vents are protected from sleet and snow by devices similar to a ventilator head, designed so that they can be easily removed for inspection.

The penstocks were assembled and riveted on the site, and were erected on blocking spaced on about 10-ft. centers. They were anchored at both ends in concrete masonry, and an additional concrete anchor block was provided about 20 ft. from the building wall. They were tested with full head of water and a careful inspection made for leaks and deformation. These tests showed the pipes to be tight, and measurements taken immediately afterward showed that no deformation had taken place. The penstocks were designed for a covering of earth to protect them from freezing, and before being covered they were backfilled with selected material carefully tamped into place under and up to the center line of the pipes. The pipes were covered with the same material to a depth of 18 in. over their tops. The underlying stratum supporting the blocking and backfill was a firm cemented gravel.

The wheels had been under test periodically for several weeks, and the penstocks were emptied from time to time for inspection. No evidences of distress were observed at any of these inspections.

Facing of Dam Slides

THE hand-laid rock on the upstream face of the Swift dam of the Valier Land & Water Company in Montana recently slid into the reservoir. The dam has a total height of about 190 ft., of which the lower 30 ft. are below the original bed of the stream. Company forces were at work putting on a concrete facing on the surface of the hand-laid rock and had reached a height of about 30 ft., when the uncovered portion of the stone face slid down. The original surface of the loose rock was on a slope of about 1 on 1. In addition to the hand-laid rock facing, enough of the loose rock came down to change the slope to about 1⅛ or 1¼ on 1. A total of about 6,000 cu. yd. slid off the face. The company proposes to suspend work until after the flood discharge of Birch Creek this season. The hand-laid rock facing had a thickness of from 2 to 4 ft.

Design of Tieplates

Concurrent Opinions of Engineers of Twenty-seven Railroads as to Size of Plates and Ribs, and Other Pertinent Features

WHILE the committee on ties of the American Railway Engineering Association is not yet ready to make definite recommendations as to the design of tieplates, it states that the replies from twenty-seven railroads out of twenty-nine show substantial agreement on the following points:

1. Plates with deep ribs or claws cut the tie so as to admit moisture and decay. The deep ribs or claws are not necessary to hold the plate in position and are undesirable.

2. Flat-bottom plates used with cut spikes become loose and the looseness results in mechanical wear of the tie. They are satisfactory when used with screw spikes.

3. Plates with cross-ribs not more than 3/16 in. deep or with other independent fastenings that will hold them to the tie do not seriously damage the tie and at the same time do not become loose and cause mechanical wear when used with ordinary cut spikes.

4. The width of the tieplate is an element to determine the mechanical wear of the tie. Plates less than 7 in. wide, for use with soft-wood ties, cut into the tie sufficiently in some cases to determine the life of the tie.

5. Plates should be of sufficient thickness to avoid cupping on either side of rail. This thickness depends on the projection beyond the rail, the amount of traffic, the kind of tie, the rate of deterioration from rust, etc.

6. Screw spikes give longer life to ties than cut spikes.

7. Where treated ties are used, all boring should preferably be done previous to treatment.

8. Ordinary driven cut spikes, by breaking down the structure of the wood for an inch or so around the spike, facilitate decay at that point where greatest strength of the tie is required. In the case of treated ties, this introduction of decay below the treatment may defeat the purpose of treatment.

9. This breaking down of the structure of the wood with the use of cut spikes is, to a considerable extent, avoided where the spike is driven in a bored hole. Spikes so driven have at least the same holding power as spikes driven without boring. Where spike holes are to be bored and cut spikes used the diamond-pointed cut spike is preferable because of the greater ease with which it follows the hole.

Concrete Apron for Keokuk Dam

It Will Cover Seamy Rock and Provide Smooth Channel for Waste Water

TO correct an erroneous impression that the dam of the Mississippi River Power Company at Keokuk, Ia., has been leaking and that its stability is menaced, the Stone & Webster Engineering Corporation has issued the following statement regarding the work, now in progress, of placing rods in the spillway sections and, in part, of constructing a concrete apron 40 ft. wide the entire length of the dam:

Early in the construction period the company's consulting engineer recommended that rods be placed in the dam to give an added factor of safety. It was the intention to install the rods while the dam was being built and a number of spillway sections were so equipped during the construction period. It was necessary to stop the work last spring on account of high water. If it had been continued it would have delayed the work of placing the concrete at a very critical time and would have interfered with starting the plant on the first of July. It was decided to finish the work of putting in the rods during the low water periods after the dam was completed, and this is the work which is now being done. The rods are of twisted steel. They are put in at an angle to the horizontal.

SCOURING ACTION

DURING the past seven or eight months the action of the water passing over the dam has scoured out some of the loose, seamy rock downstream from the toe. This action was expected from the very nature of the conditions existing. The scour has not affected in any way the rock foundation under the dam. Last fall the company started to fill up some of the holes, which had been scoured, with concrete placed in the form of an apron about 40 ft. wide. It is proposed to extend this apron the entire length of the dam and the work which was stopped on account of bad weather and high water will be continued next summer after the flood season is over and when the work can be done without excessive cost. This apron will give a clean, smooth surface over which the water can flow away from the base of the dam.

Highest-Head Hydroelectric Plant East of Mississippi River

Part II—Details of Concrete Surge Tank, Penstocks, Turbines and Draft Tube for 580-Foot Tallulah Falls Development

By CHARLES G. ADSIT and EUGENE LAUCHLI
Construction Engineer Hydraulic Engineer

AT the lower end of the 6665-ft. tunnel the surge tank is located. It is 30 ft. wide, 71 ft. long and 93 ft. high. The cross-sectional area is 2130 sq. ft., and about two-thirds of the tank lies below the ground level. For reasons of construction it was deemed advisable to give the tank a section that would render excavation easy, inasmuch as the rock at this point was hard, but badly fissured in all directions, and it proved to be no small task to keep the excavation within the specified lines. A similar difficulty was experienced in excavating the bench necessary for the gate valves at the upper end of the penstocks, and more especially in driving the tunnels for the penstocks.

CONCRETE SURGE TANK

UPON completion of the excavation it was thought desirable to lay no reliance on the cohesion of the rock. The tank was, therefore, made self-contained by reinforcing it from top to bottom with structural steel against internal hydrostatic pressure. The excavation was first carried down to grade and six tunnels, 7 ft. in diameter, 40 to 60 ft. long and 12.5 ft. on centers, were driven, each to accommodate the upper end of the 5-ft. steel penstocks. The structural steelwork was then erected in a manner similar to that used in steel-frame building construction. Wooden forms were hung inside of these 2 in. from the steelwork, and concrete was poured between the forms and the sides of the excavation, thus thoroughly embedding the steel. The horizontal bracing and ties inside of the tank were given two coats of shop paint and two field coats of cement paint. The thickness of the concrete varies from 3 ft. at the bottom of the tank to 6 ft. at ground level.

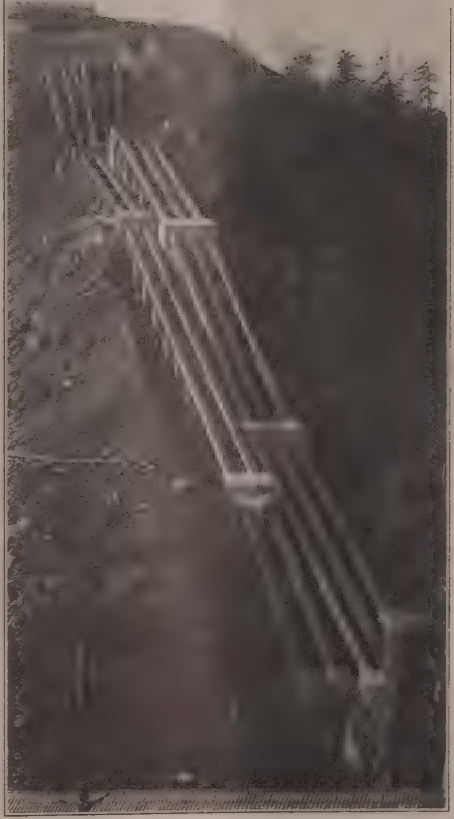
In addition to the structural steelwork, that part of the structure above the ground was reinforced against internal water pressure and temperature stresses with 5/8-in. rods, spaced from 5 to 12 in. on centers. After having been exposed to a temperature variation of 107 deg. Fahr. this structure did not show any cracks save a few surface hair lines. For the lining of the tank below ground level 1:3:5 concrete was used and 1:2:4 concrete for the upper part of the structure. A heavy concrete retaining wall was built against the face of the rock to prevent possible injuries to the penstocks and gate valves due to falling rock. The rock lying between the wall and the tank was grouted under pressure, thus sealing the whole mass.

EMERGENCY GATES

EMERGENCY gates, 8 ft. square, made of steel plates and beams and hinged at the top, have been provided at the intake of each penstock. These gates are each furnished with an 8-in. diameter filling flap gate, and they are held open by chains operated by a winch. They are to be operated only in case of accident or failure of the gate valves provided in the penstock lines.

The surge tank was dimensioned so that, with water at El. 1475 at the intake end of the tunnel, a sudden load increase of 25 per cent above normal would not cause so great a downward surge in the tank as to leave a water seal of less than 5 ft. above the top of the penstocks. The drop of water level will not affect materially the regulation of the turbines.

The accompanying diagram gives the elevation of water in the surge tank and the hydraulic gradients corresponding to loads of 50,000 and 62,500 kw with the Tallulah Falls reservoir at maximum and minimum elevations, together with the downward surges caused by a load increase of 25 per cent. The top of the surge tank was carried to an elevation that will allow no spilling of water when throwing off 62,500 kw with the storage reservoir at maximum elevation. It is anticipated that the intensity of positive surging will be somewhat damped by the assistance of the construction shaft of the tunnel, which was left open and lined with concrete.



Appearance of Penstock from Power-House Roof

The construction of the surge tank involved the following quantities: Rock excavation, 10,800 cu. yd.; concrete, 5000 cu. yd.; structural steelwork, 700 tons, and 15 tons of reinforcing rods.

When selecting the number and size of the penstocks some consideration was given to the installation of three penstocks 6.75 ft. in diameter, each serving two units. However, for the purpose of securing greater flexibility in the operation of the plant, and in order to do away with large Y distributing pipes at the bottom of the penstocks, as well as with large size gate valves and heavy plate thickness, five 60-in. steel penstocks were installed, each averaging 1250 ft. in length; adequate provision was made for the future installation of a sixth penstock.

SUPPORTING PENSTOCKS

BY using riveted pipe throughout, the maximum thickness of the plates would have been 7/8 in., necessitating heavy inside and outside buttstraps, thereby reducing the section of the pipes and causing considerable loss of head due to frictional resistance. This inconvenience was lessened by using welded pipe from a point where, for reasons of economy, the use of lap joints would have been prohibitive.

Owing to the impossibility of burying the penstocks, they were carried on concrete piers spaced 32 ft. on centers wherever possible, and heavy anchorage blocks were inserted at all vertical and horizontal bends. On account of a maximum temperature variation of 65 deg. above and below mean, due provision was made to take care of expansion and contraction in the pipe. A temperature variation of 65 deg. would only cause a stress of 12,500 lb. per square inch, a stress well within the elastic limit of the material, and would have little influence on the pipe itself. The thrust caused by expansion of a pipe 11/16 in. thick and 60 in. in diameter due to a temperature variation of 65 deg. would throw a total stress of 1,640,000 lb. on the anchorage blocks, and by eliminating this temperature stress with expansion joints a material saving could be effected in the cost of the anchorage blocks and piers, as these had to be built under difficulty, owing to the steepness of the gorge and lack of handling facilities.

The expansion joints of the packed gland type are made of soft open-hearth welded-steel plate, with an adjustable angle ring and square hemp packing. So far no trouble has been experienced due to leakage at these glands. In order to allow the penstocks to move freely over the supporting piers 12-in. steel channels were provided under the penstocks at supporting points, thereby preventing adherence of the concrete to the pipe. The penstocks are spaced 10 ft. on centers, and all piers and anchor blocks were carried down to solid rock.

QUALITY OF STEEL

THE five penstocks involve 566 tons of riveted and 605 tons of welded pipe. They were furnished by the W. B. Pollock Company, which also did the erection. The welded section was manufactured by Thyssen & Company, of Mülheim, Germany. The specifications called for soft open-hearth steel, the phosphorus not to exceed 0.04 per cent. for the welded pipe and 0.06 per cent. for the riveted pipe; sulphur and manganese not to be in excess of 0.04 and 0.05 per cent. respectively. The ultimate strength was required to be from 52,000 to 62,000 lb. per square inch; the elastic limit not less than one-half the ultimate strength, and the elongation, 22 per cent. in 8 in.

In figuring the thickness of the penstocks it was assumed that they were to resist the stresses caused by a pressure due to the net head increased by that due to water hammer when closing the turbine gates in five seconds, assuming that the relief valve of the turbine fails to perform its duty.

The water hammer was determined by using Allievi's modified formula:

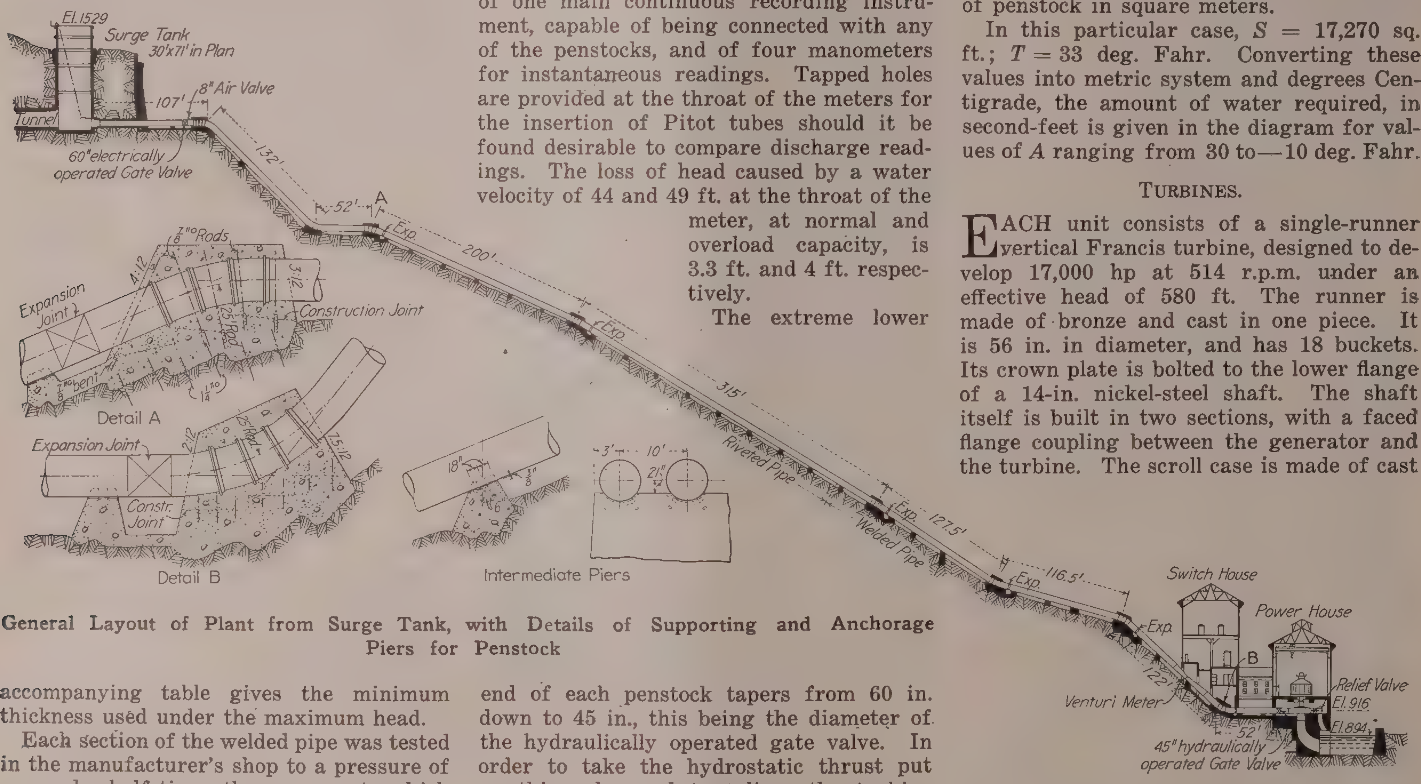
$$P = \frac{Lv}{gT} \times \frac{1}{1 - \dfrac{Lv}{2gTh}}$$

which can be used when P is less than h and when $av/2gh$ is greater than 1.

In the formula L = length of pipe in feet; v, velocity of water in penstock at time of gate closure; g, 32.2; T, time of gate closure in seconds; h, net head in feet at time of gate closure; a, velocity of wave propagation in feet; and P, excess pressure, in feet, of water hammer.

In the particular case the velocities in the penstocks with the pond at El. 1500 are 12.5 and 16.7 ft. at normal and overload capacity respectively.

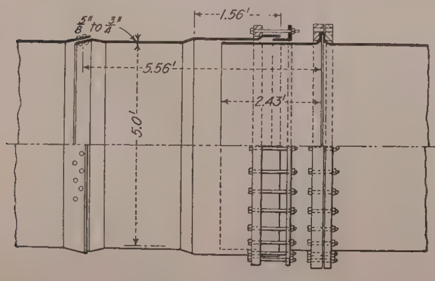
All longitudinal seams have double or triple riveted lap joints up to 9/16 in. From and including 9/16-in. plate thickness and up to 11/16-in. welded pipes are used. The accompanying table gives the minimum thickness used under the maximum head.



General Layout of Plant from Surge Tank, with Details of Supporting and Anchorage Piers for Penstock

Each section of the welded pipe was tested in the manufacturer's shop to a pressure of one and a half times the pressure to which the pipe would be subjected. After erection all field joints were calked inside and out. At angle points stiffening angles were supplied for the purpose of anchoring the penstocks to the concrete anchorage blocks. One 8-in. diameter air valve is provided in each penstock a few feet downstream of the upper gate valve, and 11 x 15-in. manholes are distributed at various points of the penstocks.

The 60-in. gate valves at the upper end of the penstocks were manufactured by the S. Morgan Smith Company; they are operated by 15-hp., 415 r.p.m. direct-current, series-wound electric motors with moisture-proof windings. They have limit switches and are controlled from the power house. Each valve is provided with an 8-in. by-pass.



Detail of Expansion Joint

For the purpose of measuring and checking the efficiency of the turbines from time to time, 60 x 35-in. Venturi meters, manufactured by the Builders' Iron Foundry, were installed on each penstock line under the switch house. The recording instruments, located in the switch house, consist of one main continuous recording instrument, capable of being connected with any of the penstocks, and of four manometers for instantaneous readings. Tapped holes are provided at the throat of the meters for the insertion of Pitot tubes should it be found desirable to compare discharge readings. The loss of head caused by a water velocity of 44 and 49 ft. at the throat of the meter, at normal and overload capacity, is 3.3 ft. and 4 ft. respectively.

MINIMUM THICKNESS FOR PIPE

Head, ft.	Thickness, in.	Type of pipe
277	3/8	Riveted
350	7/16	Riveted
416	1/2	Riveted
483	9/16	Riveted
555	9/16	Welded
590	5/8	Welded
684	11/16	Welded

The extreme lower end of each penstock tapers from 60 in. down to 45 in., this being the diameter of the hydraulically operated gate valve. In order to take the hydrostatic thrust put on this valve and to relieve the turbine scroll case from excessive stresses and distortion, a cast-steel anchorage is provided on the downstream side of the gate valve. The other end of this steel casting is connected with the turbine casing.

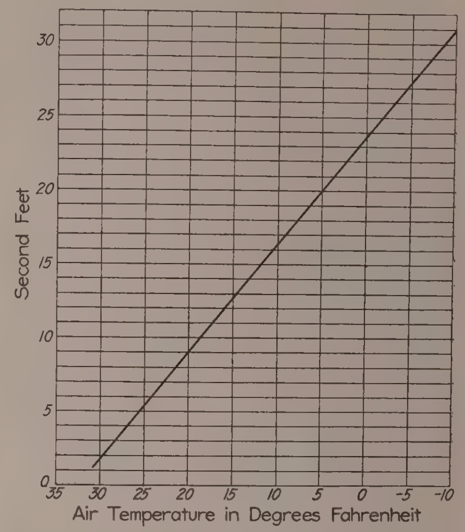
With the Tallulah Falls reservoir at El. 1500 the total loss of head from and including the intake of the turbine inlet has been figured to be 26 and 46 ft. at normal and overload capacity respectively—4.3 and 7.6 per cent. of the static head.

The lowest air temperature ever recorded has been —5 deg. Fahr. and although such an occurrence is very unusual and of short duration, it is interesting to know the amount of water necessary to pass the penstock to prevent freezing of its content during a shutdown of one unit. Bouché's formula, giving the amount of water necessary to pass the pipe per hour is

$$Q = [A - (T/2)]\ S/20\ T$$

where Q equals discharge per hour in cubic meters; A, air temperature in degrees Centigrade; T, water temperature in degrees Centigrade; and S, exposed surface of penstock in square meters.

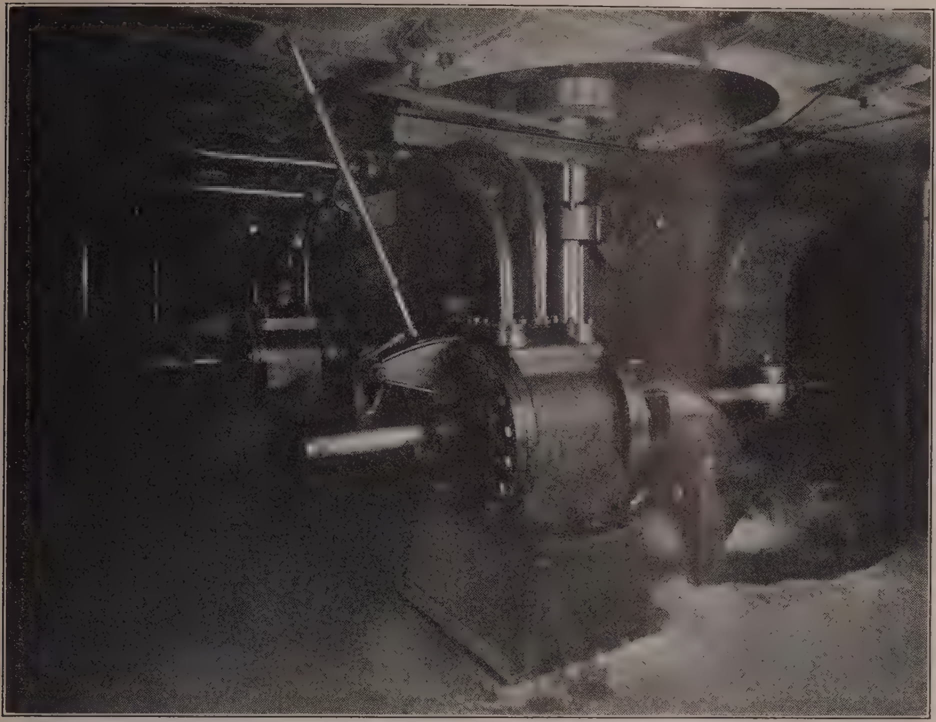
In this particular case, S = 17,270 sq. ft.; T = 33 deg. Fahr. Converting these values into metric system and degrees Centigrade, the amount of water required, in second-feet is given in the diagram for values of A ranging from 30 to—10 deg. Fahr.



Minimum Penstock Flow to Prevent Freezing

TURBINES.

EACH unit consists of a single-runner vertical Francis turbine, designed to develop 17,000 hp at 514 r.p.m. under an effective head of 580 ft. The runner is made of bronze and cast in one piece. It is 56 in. in diameter, and has 18 buckets. Its crown plate is bolted to the lower flange of a 14-in. nickel-steel shaft. The shaft itself is built in two sections, with a faced flange coupling between the generator and the turbine. The scroll case is made of cast iron, in one piece; it has a 45-in. inlet and an outlet flange connecting to the 20-in. gate valve commanding the relief valve. The scroll case has twenty-four diffusing veins, two sight holes and one manhole. There are twenty-four wicket gates, made of forged steel, which are connected to the operating ring by cast-steel cranks. The main journal is of cast iron, lined in its center with lignum-vitæ strips with end wood toward the shaft; the strips are driven in dovetail slots, the lower end being lined with a bronze ring. Directly above these lignum-vitæ strips is a chamber, piped to the live water in the outer wheel case and fitted with a valve for regulation of the height of water in the chamber, only allowing sufficient water to enter this chamber to keep the spaces between the lignum-vitæ strips full of water and to compensate for the leakage through the lower bronze ring around the shaft, thus eliminating the necessity of a packing box at this point. This water then passes into the chamber above the runner and under the wheel dome,



Chamber below Generator with Governor-Operating Cylinder and Piping

and from there is carried to the draft tube through the cored diffusers. The gate-operating ring and the operating beams are of cast steel, split through the center and bolted together.

The 20-in. gate valve between the scroll case and the relief valve has a cast-iron body and is fitted with spur gears for hand operation. The relief valve, capable of discharging 70 per cent of the water capacity of the wheel, is operated by the governor. The thrust bearing, located on top of the generator, below the exciter, is designed to carry the whole weight of the rotating parts with 150 lb. oil pressure. This pressure is furnished by two triplex pumps, each capable of withstanding 400 lb. pressure and each having a capacity of 75 gal. per minute. In order to insure the proper performance of the pressure bearing, both pumps are in commission all the time, one pump being driven by the turbine and the other by a 35-hp electric motor.

DRAFT TUBE.

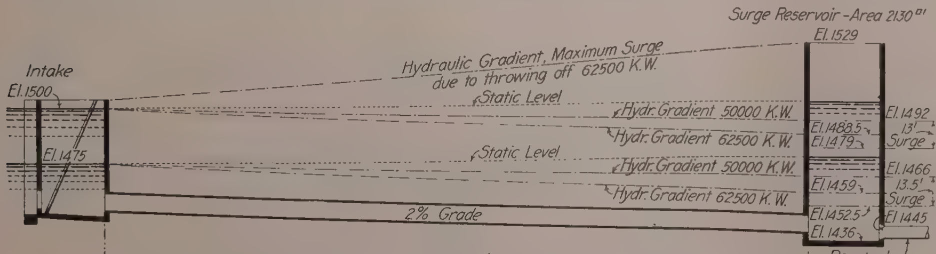
THE upper part of the draft tube is made of cast iron and has a diameter of 3.33 ft. Its lower part is made of steel plate embedded in the concrete, and has an outlet diameter of 8 ft. A quick-closing gate valve serving the purpose of breaking the vacuum in the draft tube, if necessary, is provided on the turbine floor. The wheel case and gate valves were tested in the manufacturer's shop to a pressure of 400 lb. per square inch before shipment.

The belt-driven, Weber type, oil-pressure governor actuators are located on the generator floor. The generating cylinders, two for each unit, are lined with bronze. Each is capable of exerting 60,000-ft.-lb. energy. They are mounted on base plates secured to the scroll case and bolted to the concrete floor. The governor can be regulated to trip the relief valve at any point of the gate opening, and the governor cylinders are fitted with a device by means of which the turbine gates can be opened or closed by hand or by an electric motor should the governor be out of commission. The governor, when adjusted to close the turbine gates in five seconds, will cause the pressure in the penstocks to increase not more than 20 per cent when the full load is thrown off. With a flywheel effect of 1,250,000 ft.-lb. in the rotor of the generator, the speed variation specified for 25, 50, 75 and 100 per cent load variation is not to exceed 3, 7, 13 and 20 per cent, respectively, above or below normal.

The 45-in. diameter hydraulically operated gate valve has a cast-iron body and a cast-steel valve disc, faced with bronze. The valve stem is of forged steel, covered with bronze. The cylinder is 26½ in. in diameter, and the piston, made of cast iron with cast-steel followers, has a 48-in. stroke. The cylinder is of cast iron lined with bronze. The valve stem, passing through the upper cylinder head, is equipped with a cross-arm operating the relay valve which regulates the pressure for raising or lowering the valve disc. The valve has an 8-in. diameter by-pass with hand wheel command on the generator floor. For the purpose of providing light and power during shutdown periods of the main units, a 50-kw, 250-volt, direct-current generator, driven by a 125 hp Pelton wheel, governed by a Lombard water-type governor, has been installed. The erection of the generating units and their appurtenances was accomplished by means of a 60-ton Shaw crane having a span of 40 ft.

Water discharges from the draft tubes into the tailrace blasted out of the bed of the Tallulah River. The tailrace is protected from floods by a heavy concrete wall, which also keeps out débris. Provision has been made at the downstream end for the installation of a measuring weir, thus enabling the efficiency of the turbines to be determined by means of Venturi meters and Pitot tubes, and by weir measurements. Except as noted above, the turbines and appurtenances were manufactured by the S. Morgan Smith Company, of York, Pa.

The Tallulah Falls hydroelectric development, including storage dams, power plant, transmission lines and substations, is being built by the Northern Contracting Company. H. M. Atkinson is president and chairman, and G. V. Brine, vice-president and general manager. The Georgia Railway & Power Company was represented by P. S. Arkwright, the president, and Charles O. Lenz, the chief engineer. John Birkenbine is retained as consulting engineer in connection with the design and construction of the Mathis dams, and H. T. Hartwell is the resident engineer at Mathis for the Northern Contracting Company.


Surge Reservoir - Area 2130□'
El. 1529
Hydraulic Gradient, Maximum Surge due to throwing off 62500 K.W.
Intake
El. 1500
Static Level
Hydr. Gradient 50000 K.W.
Hydr. Gradient 62500 K.W.
El. 1492
El. 1488.5
El. 1479
13'
Surge
El. 1475
Static Level
Hydr. Gradient 50000 K.W.
Hydr. Gradient 62500 K.W.
El. 1466
El. 1459
13.5'
Surge
2% Grade
El. 1452.5
El. 1445
El. 1436
Tunnel 6665'
Penstocks

Changes in Hydraulic Gradient Due to Water Hammer in Penstock

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New Water Project for Johannesburg

Proposal to Impound Twelve Billion Gallons in Transvaal Stream to Increase Rand Supply

A PROPOSAL to build a dam ¼ mile long in the Vaal River near Johannesburg, South Africa, to increase by 12,000,000 U. S. gal. per day the water supply of the surrounding district has been made by the Rand Water Board, according to information received from W. Ingham, chief engineer.

The length of the natural reservoir to be formed is estimated at 40 miles, and the capacity will be more than 12,000,000,000 U. S. gal. The dam, which will be located 23 miles below the town of Vereeniging, is to be 1456 ft. long, containing 36 gates 30 ft. wide and 23 ft. deep. The supply will be taken at Lindequees and the delivery will require 43 miles of pipe, in sizes of 24, 30 and 33 in.

The estimated cost of the project is $5,720,610 and the amount which is available for borrowing is about $6,100,000. Mr. Ingham stated that the board intended during the session which commenced about Feb. 1 to apply to Parliament for the necessary power. It will probably be June or July next before this authority will be obtained, and in all probability tenders will not be called for until September next.

Brüxer Dam Completed

THE Brüxer dam in Bohemia, 175 ft. high, was completed recently. The structure, which is the highest dam in central Europe, contains 164,000 cu. yd. of cyclopean masonry. When full the reservoir holds 53,000,000 cu. ft. The dam is built for the water supply of the city of Brüx, but the 7½-mile pipe line connecting the reservoir with the city distribution system will not be completed before June.

Electrification of Mount Royal Tunnel

Analysis of Choice of 2400-Volt Direct-Current System for Combination of Trunk-Line Locomotive and Suburban Motor-Car Service

DECISION has been made to use the 2400-volt direct-current system for the electrification of the tunnel and terminal of the Canadian Northern Railway at Montreal. The electric zone will extend through the 3-mile tunnel under Mount Royal (described in the issue of June 28, 1913, page 708) to Cartierville, a point 5 miles beyond the tunnel, where a large classification yard will be established. Both trunk-line and suburban service will be operated, and the reasons for the choice of the 2400-volt direct-current system for this combination of traffic are set forth by W. C. Lancaster, electrical and mechanical engineer for Mackenzie, Mann & Company, Ltd., builders of the tunnel, in an article in the "Electric Railway Journal." The following is an abstract of his paper:

REASONS FOR ELECTRIFICATION

ELECTRIFICATION of the tunnel was necessary for comfort and safety. It was also necessary for the operation of the trains in the passenger terminal, where the tracks will be beneath the terminal buildings and about 45 ft. below the street surface. As this amount of electrification had to be installed, it was decided to extend the electric zone to Cartierville, so that multiple-unit trains could be run, and because the yard at that point would provide a convenient place for changing locomotives. As a basis for the study of what system of electrification should be used train schedules and train weights were assumed that, it was thought, would probably be used. No exact operating data were available at the time, but recourse was had to the statistics of the two other large railroads entering the city.

Four systems of electrification were considered: Three-phase 3300-volt to 6600-volt trolley; single-phase 11,000-volt trolley; low-voltage direct current 600-volt third-rail, and high-voltage direct-current 1200-volt to 2400-volt trolley.

CONSIDERATION OF THREE PHASE

THE chief arguments in favor of the three-phase system are the regeneration of energy on steep grades and the resulting economy both in energy consumption and wear of brakeshoes and tires, and also, in common with other alternating-current systems, the economy of transformation by means of stationary transformers instead of rotating machinery.

In this case, however, the first of these advantages did not apply, as the maximum grade throughout the whole of the electric zone is only 0.6 per cent. As regards the last advantage, it was expected that electric energy would be purchased rather than generated by the railroad company, and as all the available power in Montreal was at sixty cycles, whereas fifteen cycles or twenty-five cycles is required for this system, rotating machinery in the shape of frequency changers would have been necessary. This, of course, would have eliminated the greater economy of transformation that this system claims over direct current.

The chief disadvantages of this system appeared to be necessity for two trolley wires and two collectors insulated from each other, complicated and inefficient speed control, high peaks on the substation due to the constant-speed characteristic independent of the torque, constant-speed characteristic unsuitable for multiple-unit trains and low power factor.

To balance these disadvantages there remained only the absence of commutators as an argument in favor of the three-phase system, and the modern direct-current railway motor with commutating poles is so reliable that the objection to the use of a commutator is largely a thing of the past.

CONSIDERATION OF SINGLE PHASE

HIGH efficiency of transformation and transmission seems to be the principal reason which makes single-phase electrification attractive. As has already been pointed out, however, the use of any alternating-current system for the Montreal terminal would mean frequency-changer sets which would at once put this system, so far as the substation apparatus is concerned, on a par with direct current.

At first sight an 11,000-volt trolley promised considerable economy, especially when the possibility of future extensions some distance beyond the present electric zone was considered; but after careful calculations were made it was found that no such voltage was necessary, 2400-volt direct current being ample, even for 25-mile substation spacing, without excessive feeder copper.

A serious handicap to single-phase electrification was the large number of multiple-unit motor cars required for the suburban service. It was found that the cost of these would be very high compared with direct-current equipments, owing chiefly to the motors being heavier and more complicated for the same output.

As regards operation, it was thought that the cost of maintenance of the single-phase system would be somewhat greater than either low-voltage or high-voltage direct current, especially when the interference, due to induction, with neighboring telephone and telegraph lines was considered.

LOW-VOLTAGE DIRECT CURRENT

IT might seem, without going fully into the question, that a 600-volt contact system would be ample for this electrification of only 9 miles length. When the heavy trains are considered, however, it was found that two substations instead of one would be necessary, and also that a third rail would have to be used on account of the heavy current. Trouble from snow and ice in the deep cut west of the tunnel was feared if a third rail should be installed, and it was thought that the maintenance of this type of conductor in the two yards and in the passenger and freight terminals would be higher than that of an overhead trolley.

There were two important points in favor of this low-voltage direct current, namely, its absolute reliability, proved by years of use on electric roads all over the world, and the comparatively low cost of the electric motor car and locomotive equipments. However, it was found that the cost of the large amount of feeder copper and the additional substation would about balance the saving in the cost of rolling stock. As this low voltage was obviously unsuitable on account of the excessive cost for extensions of any considerable length beyond the 9-mile zone, it was thought best to use a higher trolley voltage.

HIGH-VOLTAGE DIRECT CURRENT

THE chief objection to the 2400-volt direct-current system is that it is experimental, but this is not so serious as might appear. The first railways to use the higher direct-current voltage obtained a trolley potential of 1200 volts by the use of two 600-volt generators wired together in series, the 600-volt railway motors also being wired in permanent series. The next step was to wind these machines for 1200 volts so that one could be used instead of two in series. It seemed, therefore, a comparatively simple matter to go a step further and wire two of these motors or generators wound for 1200 volts in series and insulate them for 2400 volts. That this could be done satisfactorily has been abundantly proved by the Butte, Anaconda & Pacific Railway in Montana. [See Engineering Record of March 14, page 303.] With convincing proof that the use of 2400 volts direct current would not be experimental and would prove to be reliable, it soon became evident that this higher voltage was better suited to the heavy electrification contemplated for the Montreal terminal than 1200 volts and 1500 volts.

After the somewhat greater cost of the 2400-volt locomotives and car equipments was balanced against the extra copper and extra substation required for these lower voltages, it was found that 2400 volts would not be any more costly for the 9-mile zone only, and in case of any large extensions it worked out far cheaper than 1200 volts and 1500 volts.

POSSIBILITY OF STILL HIGHER VOLTAGE

THERE is another advantage in the use of 2400 volts which some may criticise as being too visionary but which in the opinion of Mr. Lancaster is a very real point. The tendency in electric-railway development seems to be strongly toward direct-current potentials even higher than 2400 volts. Much experimental work is being done along this line. While 2400 volts is quite high enough in certain instances, where grades are steep and loads are heavy, an even higher voltage would be desirable.

The advantage of 5000 volts for long trunk-line electrification would be enormous. It is chiefly a very high trolley voltage which makes single-phase current appear so attractive. Undoubtedly the successful development of 5000 volts direct current would mean that many railroads would find it exceedingly profitable to electrify for long distances where just the reverse would be the case if a lower voltage had to be used. This is especially true in Canada, where cheap water power can frequently be obtained along the right-of-way and where the expense of operating steam locomotives during the bitterly cold winters of the country is so great.

By using 2400 volts now, if 5000 volts should ever become desirable, the motors for the higher voltage being wound for 2400 volts and operated two in series on 5000 volts, could readily be operated in multiple on 2400 volts at full speed, just as 1200-volt equipments are now run at full speed on 600 volts. Using 1200 volts now, an ultimate change to 5000 volts would require half-speed operation of the 5000-volt equipment over the 1200-volt trolley.

Dynamiting Ice Jams

Hints as to Proper Methods of Opening Up Rivers to Prevent Flood Damage

By ARTHUR LA MOTTE
Of the E. I. Du Pont De Nemours Powder Company, Wilmington, Delaware

THIS is the time of the year when ice in the rivers is breaking up and forming great barriers which choke the waterways and cause floods. About the only measure that offers hope of immediate relief from the danger attending an ice jam is to dynamite it. There are two general methods of procedure—one is to break up the ice in place without attempting to move it, so that it will be moved away by the pressure of the water when it strikes it; the other is to break up and remove the whole body of ice, beginning at the downstream end and breaking up the mass of ice and pushing it into the current as fast as it is loosened from the main body.

In an emergency, where much property is at stake, both of these methods may be used at the same time. Thus one gang of men can be employed on the up-river end breaking up or "honeycombing" the ice as it is packed and the other gang on the downstream end breaking off and floating away the ice and working toward the other gang.

CHARGES SHOULD BE SUBMERGED

IT is a waste of time and money to attempt to explode charges on the surface. It takes enormous charges of dynamite to break the ice in this way, and even then about all the explosive does is to punch holes in the ice. The proper method is to explode charges of dynamite in the water under the ice and, if possible, against the ice. This lifts up the ice in a large radius, breaks and cracks it in all directions, and if done in a line of charges extending across the channel can start an immense quantity of ice at one operation.

The method usually employed by experienced men for starting an ice jam where the danger is not particularly imminent is to punch a line of holes across the channel on the down-river side about 20 ft. apart and 20 to 30 ft. back from the clear water. These holes can be made either by chopping with an axe or by sharpened steel bars or by the churn drill with a cutting edge about 4 in. in diameter, operated by two or three men. The holes should be 4 or 5 in. in diameter at least for ice up to 3 ft. thick. For this thickness of ice seven cartridges of 60 per cent dynamite, tied securely in a bundle with an electric blasting cap firmly inserted in one of them, are let down through the hole and allowed to be taken by the current a foot or two and held by it against the under side of the ice.

The best explosive for this purpose is Red Cross straight dynamite, which is low freezing and which is not affected by the extremely cold water unless exposed to it for an unreasonably long time. Thicker ice requires proportionately larger charges of dynamite, the amount necessary being determined by experiment. When the area of breakage extends from one hole to the other so as to shake it up and loosen it thoroughly, the charges are about right.

When charges of more than seven cartridges have to be used up to, say, 200 lb., the hole in the ice made as described above can be enlarged by firing a charge of four or five cartridges of dynamite placed about half way down in it. The final charge is then put in a gunnysack, primed as before, floated down under the ice and exploded.

For opening a channel 150 ft. wide on the Mohawk River in the winter of 1911 charges of from six to eight cartridges of 60 per cent dynamite were exploded under the ice at intervals of about 30 ft. This broke up the field so that the cakes could be barred loose and pushed downstream. The operation was then repeated, working upstream until the entire mass was removed.

One reason why dynamiting ice jams is frequently unsuccessful is that the operator has an idea that a small quantity of dynamite is infinitely powerful, or that there is no limit to the work that one cartridge of dynamite will do, whereas there is a very definite limit. At one town where the bridges were threatened by a very serious ice gorge the chief of the fire department undertook to dislodge a mass of ice 15 or 20 ft. thick by exploding a piece of dynamite about 4 in. long on top of the ice. He might just as well have used a fire cracker, for all the execution it did.

It is an expensive business and a serious matter to undertake to dislodge a bad ice gorge with dynamite and the person in charge should be someone who has had actual experience with the use of high explosives in some kind of material, even if he has not previously employed dynamite to dislodge ice gorges.

Penalties and Liquidated Damages

Delays in Delivery of Supplies on Contracts with Navy Department and Isthmian Canal Commission

By WILLIAM B. KING
Of the Bar of Court of Claims, Washington, D. C.

MANY of the contracts for machinery, materials and supplies made by the Navy Department and by the Isthmian Canal Commission contain provisions for deducting, on account of delay beyond the contract time, one-tenth of 1 per cent of the value of the goods not delivered. To this provision a proviso is added that "if the Government has suffered no damage or inconvenience on account of the delay, such delays may, in the discretion of the bureau, be accepted as sufficient cause for waiving such deductions or cancellation as herein provided."

The question was raised before the Treasury Department whether the deductions "as herein provided" were uniformly to be made in case of delay, as provided in the contract, unless an express waiver was made by the proper officer of the Government for one of the reasons stated in the contract; or whether the Government was obliged to show affirmatively, to warrant the deduction, that actual damage had been caused to the Government by the delay.

The decisions of the courts have for many years drawn a distinction between a "penalty" and "liquidated damages." The rule of law is that, if the contract provides a "penalty" for delay, the person claiming the penalty must prove actual damages by the delay; if the contract calls for "liquidated damages," the person claiming the damages is not obliged to show any actual loss, but the liquidated amount stated in the contract is taken by agreement as an actual assessment of the loss.

The general rule of the courts is that the use of the words "penalty" or "liquidated damages" does not necessarily control the nature of the deduction. The word "penalty" has been construed to mean "liquidated damages," and vice versa. There is no branch of the law in greater confusion. The different States are in hopeless conflict.

The comptroller of the Treasury, in a case containing such a provision, declared that the object of liquidated damages was to fix by agreement the actual damages and that no court or other authority could set aside the agreement of the parties, if it were shown that they wished the liquidated amount named to be regarded as the actual damage. But, he said, in this particular case the intention which otherwise was made plain—to deduct a certain amount—was obscured by the provision that in case there was no damage from the delay the amount previously fixed could be waived. It could not be said that the parties had agreed on the damages, when it was declared later in the contract that there might be no damages. For this reason the comptroller said that the contract provided a penalty. He required the Government affirmatively to show that damages had been incurred and, in the absence of such showing, said that the liquidated amount stated in the contract should not be deducted.

A good many refunds were made to persons furnishing engineering and other supplies on the Isthmian Canal and to the navy yards under this decision. A later decision of the comptroller held that the final receipt by the parties deprived them of the right to make further claims, and this forced later cases to be taken to the Court of Claims.

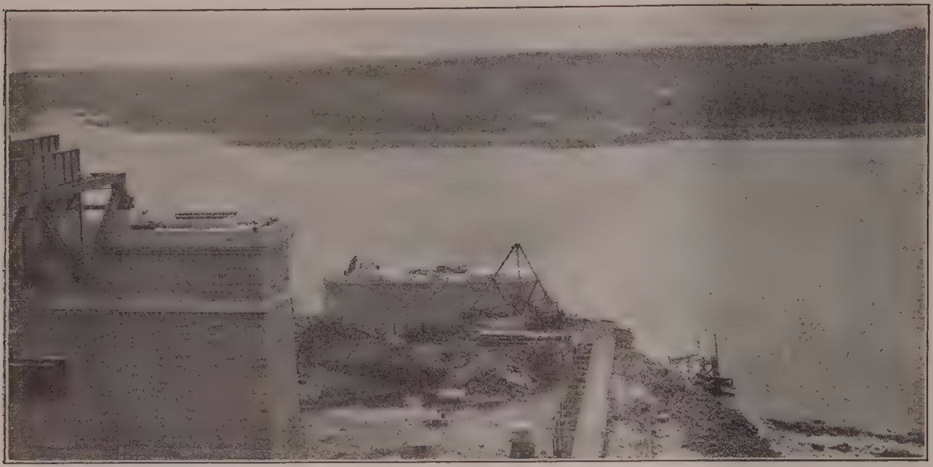
FIRST TEST CASE

IN the first test brought before the Court of Claims, that of the Crane Company, the court rendered an opinion in 1911, reversing the decision of the comptroller and holding that these contracts provided liquidated damages, and that these must be deducted unless the proper officer of the Government declared that no damage or inconvenience to the United States Government had been incurred.

The contractors interested were not satisfied with this decision and brought another case before the court, that of the Pacific Hardware & Steel Company. It was again argued, and in 1913 a decision was rendered reversing the previous court decision and holding that the comptroller was right and that damages could not be assessed unless the Government showed that actual damage had been suffered. The Government moved for a new trial in this case. It was recently argued, and on Feb. 9 the Court of Claims decided that the comptroller was wrong; that its original decision in the case of the Crane Company was right; that its later decision in this case was wrong, and that the Government was entitled to deduct the damages as fixed in the contract.

The case is an interesting example of the uncertainty of the law on this subject. Unfortunately, it cannot go to the Supreme Court of the United States because the sum involved in any particular case is less than the jurisdictional amount for the Supreme Court, namely, $3,000.

The Court of Claims in a learned opinion cites the decision of the Supreme Court of the United States in the celebrated case of the Sun Printing Association vs. Moore, 183 U. S. Reports, 669, and takes the position that the agreement of the parties settles their rights and that the literal terms of the contract must govern.



Present Appearance of Quebec Bridge Site

Progress at Site of Quebec Bridge

Substructure and Approach Spans Completed; Storage Yard and Contractor's Camp Established; Steel Received and Traveler Tower Erected

IMPORTANT progress has been made in the construction as well as in the design and fabrication of the $12,000,000 Quebec Bridge, and although the work is not yet imposing from the layman's standpoint, it has reached a stage and has included preliminaries that will permit rapid future progress. At the site the short approach spans and the difficult and costly substructure for the main span have been completed, a camp established, contractor's yards laid out, plants installed and operations commenced in the storing of superstructure steel and the erection of traveler and falsework, thus providing for vigorous operation in the spring and for the erection of the main steelwork, which is now being fabricated and shipped to the site.

SUBSTRUCTURE AND APPROACHES

THE two large main piers, located 1800 ft. apart on the edges of the very deep-water channel, are of concrete construction with masonry facing and pneumatic-caisson foundations. The anchor piers, 2830 ft. apart, are of similar construction, with foundations on solid rock above water level. They are a few feet eccentric from the old piers, so as to clear them instead of utilizing a portion of them, as was at one time intended. The old piers have been removed to low-water level, and part of the stone masonry contained in them has been used in the new construction, which has been described in several articles published in the Engineering Record. The short approach spans at the north end of the bridge have been erected and standard-gage tracks on them connected with the railroad branch, so that material and equipment can be received and stored and the erection of the main spans can be undertaken as the falsework for the anchor arms is erected. The construction equipment is installed and the steel is at the site.

Erection will be commenced this spring at the north end of the bridge and at the south end next year, after which the work will progress simultaneously on both sides of the river until completion. At present the principal activities are on the north side of the river, but will be substantially duplicated on the south side in time to commence the erection there as soon as required by the program of scheduled operations.

NORTH SHORE PLANT

AS the bridge site is in a rural district at considerable distance from towns large enough to provide convenient accommodations for the workmen, a construction camp has been established on the north shore to accommodate the erection force. Quarters have been provided for the engineers and other officers of the bridge commission and the contractors. The camp contains bunk houses with steam heat, electric lights and artesian water supply, besides which there are an office building, a commissary, kitchen, dining room, wash house, hospital, police station, repair shop and storage houses. Owing to the severity of the climate the working season for erection is limited to about six months, and the camp, which will be in service about four years, has been constructed with a view to durability and comfort for at least that length of time.

The power house is of fireproof construction and is equipped with four Ingersoll-Rand air compressors—one of which is intended to be kept in reserve—with a combined capacity of 2000 cu. ft. of free air per minute. The compressors are operated by 220-volt alternating-current motors of 100 hp each, and two 250 kw motor-generator sets are installed to reduce the 2200-amp current to 220 alternating current for the operation of the motors on the erection travelers. All of the principal installation is in duplicate and is proportioned so that there will always be a reserve.

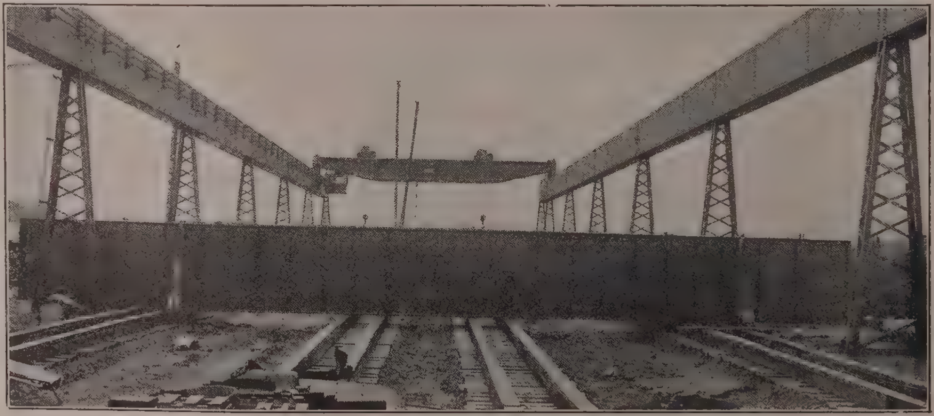
The electric current is purchased by the contractor and is delivered on both sides of the river and connected by a cable across the channel so that either side may supply the other side. A duplicate plant will be established on the south shore of the river, thus providing for the eventual installation of four units, which, besides affording flexibility and reserve, were found to be cheaper than the installation of a single large plant with the required total capacity and excess.

The main travelers are each operated by mill-type General Electric motors. It is estimated that a total of about 500 hp on each side of the river will be required for all erection purposes when the work is in maximum progress, and that of this amount about 500 hp will be required to operate the air compressors which supply power for the pneumatic tools. Although a capacity of 800 hp is provided, it is expected that not more than 400 or 500 hp will be used at any one time.

STORAGE YARD

THE storage yard is commanded by a two-trolley 90-ton girder crane of 81 ft. 3½-in. span, traveling on a runway 495 ft. long. The space commanded is crossed at one end by two standard-gage service tracks connecting with the bridge track and with the railroad branch. The remainder of the space between the runway girder is occupied by four full-length lines of double timber skids 4 ft. apart on centers, which have a capacity sufficient for the storage of all the steel required for either the anchor arm or the cantilever arm.

The girder crane and runway are substantially duplicates of those already installed in the storage yards of the fabricacation shop in Montreal, and will eventually be removed there to supplement them. Excepting 33 ft. and 49½ ft. odd spans at the ends, the runway girders are 66 ft. long and are supported on battered steel columns 7 ft. wide transverse to the tracks at the base. Each column is made of four corner angles united by lattice angles and having the upper ends bent vertical and riveted between the inner faces of the double runway girders. The columns on one side of the runway are staggered with those on the opposite side so as to allow members longer than the width of runway to be moved to any position without turning.



Storage Yard with Its 90-Ton Traveling Girder Crane

How the New Quebec Bridge over St. Lawrence River Will Look When Completed

Erection of one of the main travelers was commenced on shore at the north end of the bridge last fall and was completed to the top of the tower, a little beyond the point shown in the accompanying illustration, before work was suspended for the winter. The traveler, about 200 ft. high, has clearance between the trusses of the permanent structure and is of heavy riveted construction with a vertical tower of rectangular cross-section made with four vertical posts X-braced on all faces and horizontal bracing at each panel point.

The base of the tower is extended by trusses projecting from one side and is supported by four six-wheel trucks running on two 6½-ft.-gage tracks. A pair of vertical trusses framed into the top of the tower cantilever 50 ft. front and rear and serve as runway girders for a pair of traveling cranes of 110 tons capacity with nickel-steel girders. These girders cantilever beyond both sides of the traveler so as to extend across the trusses and command them with their 55-ton trolley hoists.

The traveler weighs about 930 tons, or, with its full equipment, about 1000 tons. It will be provided with electric passenger elevator and hoisting apparatus. After erecting the falsework, the anchor arm and the cantilever arm on the north side of the river will be dismantled and reassembled at another site for the erection of the 640-ft. 5000-ton center suspended span on shore falsework.

The fabrication of the 7400 tons of steel in the floor system of the entire bridge and of the 1400 tons of inside falsework and 470 tons of outside falsework for the north shore has been almost completed, and on Feb. 1 about 8000 tons of steel had been shipped to the site, besides 1000 tons of floor system which had been completed and which are still stored at the fabricator's shops.

The work is under the direction of the board of engineers, of which C. N. Monsarrat is chairman and chief engineer. It is being executed by the St. Lawrence Bridge Company, of which Phelps Johnson is president and G. H. Duggan, chief engineer.

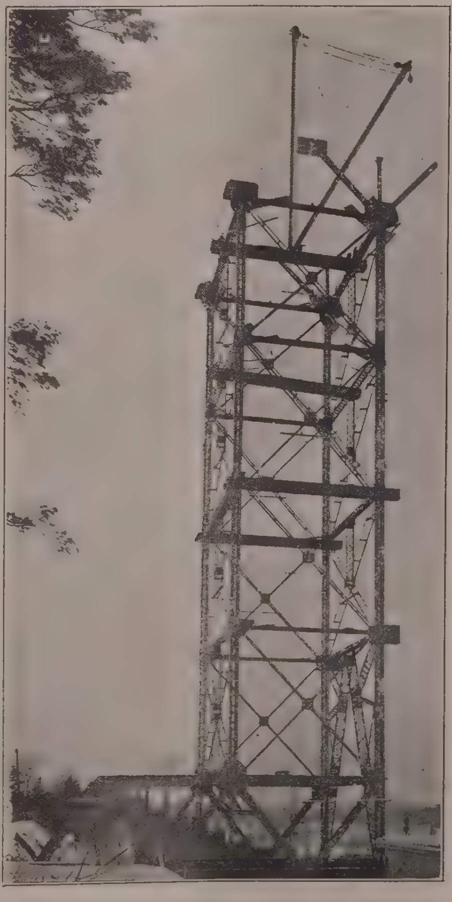
MONEY FOR POWER rentals under the form of power permits granted by the Secretary of the Interior has been received recently for the first time, and it illustrates the working of the policy to develop the water power of the West in such a way as to benefit the public generally as well as the local community. The money was received in two checks—one from the Truckee River General Electric Company, of Reno, Nev., for $51.72, and the other from the Great Falls Power Company, of Butte, Mont., for $367.46.

Bridge Rivets of Unusual Size

Sizes as Great as 1 1-8 Inches in Diameter and 12 Inches Long Were Used on Quebec Bridge Work

FABRICATION of the very large members of the new Quebec Bridge required the driving of numerous long carbon-steel rivets of large diameter, and unusual pains have been taken at the St. Lawrence Bridge Company's shop in their perfection and in the demonstration of the results obtained in driving them. Satisfactory results are reported to have been secured for the 1⅓-in. iron rivets in the pedestals under the main vertical posts. These rivets have a 9-in. grip and are 12 in. long before driving, thus requiring great efficiency in the machine and making it a difficult and costly matter to attempt cutting out and redriving, so that it is essential that they should be satisfactory at the outset.

The requirements are for the rivets to be driven at a cherry red. The cylindrical holes are drilled or reamed to a uniform diameter and the rivets are tapered about 1/32 in. in 12 in. from the end near the first head so as to completely fill the hole there when inserted. The points are chilled by being dipped in water before driving, thus tending to increase the upset in the middle of the shank, and the first heads are made long, affording a sufficient excess of metal to insure the formation of a 1/16 to 3/16-in. burr next the metal.



Quebec Bridge Traveler

These rivets are driven as fast as those driven at a much higher temperature, and are not subjected to as much stretching by the springing of the riveted plates as when rivets are hotter. The driving has been so successful that practically no rivets have been condemned and cut out. Heating the rivets to a very high temperature for driving is objectionable on account of the scale that is formed and because the metal is then too soft to transmit the compression and produce a sufficient upset a long distance from the driven head.

PNEUMATIC DRIVING MACHINES

THE shop rivets are driven with pneumatic yoke machines and the field rivets will be driven with pneumatic guns and special pneumatic buckers-up having a pneumatic hammer contained in the plunger and operated during the first part of the driving. The plunger is controlled by a special valve, which first sets it up against the riveted member and maintains the pressure, after which the hammer may be simultaneously operated until the rivet is nearly driven from the opposite end, when this hammer is stopped and the static pressure continued until the driving is completed by the gun.

Specimen 1⅛-in. rivets 12 in. long were driven through several plates by the 80 and 100-ton yoke machines and by the pneumatic hammers. Afterward the plates were planed apart through the center line of rivets and those driven by the pneumatic hammers were found to be as good as those driven by the yoke machines and almost indistinguishable from them, all of the rivet holes being completely filled.

REMOVING ANCHOR ICE from an intake pipe line of the waterworks at Moline, Ill., is accomplished by means of air, which is furnished by a Roots blower used in the washing of the rapid filters, according to a paper recently presented to the Illinois Water Supply Association by L. A. Fritze, chemist of the Moline Water Department. A 2½-in. pipe from the blower is tapped into the inner end of the 300-ft. length of a cast-iron intake line extending into the river. Ordinarily, a pressure of 10 lb. is used for the filters, but as high as 30 lb. are used to loosen the ice, which seems to collect around the unprotected end of the pipe and on the inside of it. The slight increase in temperature and the impact of the air were given as probable reasons for the successful clearing of the line.

San Francisco Street-Cleaning Department Assailed

Three Months' Investigation by Civic Committee Indicates Incompetent Administration and Need for Drastic Change in Methods

REORGANIZATION of the municipal street-cleaning department of San Francisco has been demanded by the municipal affairs committee of the chamber of commerce. The committee claims that as at present administered at least a third of the $350,000 annually appropriated for the work is being wasted. This committee, of which George C. Boardman is chairman and Henry A. Campbell engineer, has issued a report of an investigation extended over three months, beginning Aug. 21, 1913. The report, written by Mr. Campbell, was adopted by the chamber of commerce on Jan. 16.

The investigation covers one phase of an inquiry into the methods of disposition of the rapidly increasing tax-levy funds, which are used to meet the current expenditures of the city and which will total about $14,000,000 for the fiscal year 1913-14. After the first observation criticism of the methods used was made to the superintendent. The report very bluntly states that this official either did not know what was going on in his department or was not altogether frank in his explanations. After this occurrence the night gangs "speeded up" when the presence of the investigators was known. Subsequent activities were, therefore, prosecuted quietly.

After mentioning the classes into which the work is now divided, the organization and equipment of the department—the monthly payroll is $28,500 and the minimum wage $3 per day—and the committee's views of the principal aspects of the street cleaning problem, the report describes the inspections, of which nineteen were made in the wholesale and business districts and twenty-five in sections typical, in proportion of business and residence occupancy and in character of traffic, of the greater part of the city. The record for each inspection includes the organization of the gang, what streets were swept and how thoroughly, the hours spent in work, the number of loads carried and a comparison of the record with the results claimed in the foreman's report. At intervals summaries of these candid remarks are given, to which the reader's attention is called by a note on the cover of the reports, "Read pages 21 to 23, 35, 36, 48, 49, 53 to 55 and 61 to 63." These observations are given in condensed form in the remainder of this review.

NIGHT CREW IN DOWNTOWN DISTRICTS

WITH one exception the work of the hand gang on the dates in question did not exceed six hours and fifty-five minutes per shift, and once three hours and fifty minutes was the interval. Furthermore, the men are accustomed to decrease in speed when it seems that they will finish the prescribed amount of work too early. Unintelligent assigning of work is indicated by a comparison of rates at which sweepers piled gutters in the Commission District under identical conditions. On Sept. 2 ten men piled 771 lin. ft. per hour per man; Sept. 5 eleven men piled 785 ft.; Sept. 10 six men piled 1025 ft., and Sept. 12 eight men piled 980 ft.

The working time of the machines did not exceed seven hours, and in most cases their work was slow. By a proper routing so that the full battery of three machines is not required to traverse the narrow streets, much time can be gained to be spent on sweeping other streets not now swept.

The fact that the men cover the districts at varying rates, always in less time than the full eight hours, proves that these should be enlarged. Moreover, the same blocks are covered by hand and machine crews, and report is so made.

FALSIFICATION OF REPORTS

ON no occasion, while under observation, did the dirt teams haul from any district the number of loads they might reasonably be expected to remove. The trouble lay not so much in the rate of loading—though this was at times too slow—but in the fact that they never worked a full shift of eight hours. When, from slow work, they failed to remove even their customary amount the false reports turned in by the dump man and foreman effectively concealed that fact. Such falsification of reports as has been encountered, states the report, is only possible where a foreman feels himself secure from detection—either from lax supervision or ignorance on the part of his superior. An intelligent reading of the foreman's reports, together with a knowledge of the district covered thereby, ought to convince the department heads that someone was "slipping something over."

As yardage is paid on all dirt hauled to Beach Street dump, the reporting of loads not hauled is evidence that other items than wasted time and misdirected energy enter into the city's loss.

It is estimated that 35 per cent of the payroll of this night gang is wasted through failure to work full time, loafing on the work, overpayment for dumping at Beach Street, and misdirected and unintelligent supervision of the work.

DAY INSPECTIONS

THE same faults were detected in observations of work, during the day, on four of the fifteen typical sections. Criticism is also made that the teams are able to pick up and haul away more dirt than the gangs collect.

The theory of the foreman-sweeper, according to Mr. Campbell, is that for an increase in pay of 50 cents per day he shall supervise the sweepers of his gang and direct the teams. In these districts the title of "foreman" has simply been used as an excuse to neglect the duties of a sweeper. There is no reason why he should not sweep at least 90 per cent of his time.

Another abuse is noted in the rate the city pays for teams and wagons—$6.50 for what is supposed to be an eight-hour day. The union rate is $6 per day for ten hours, and this includes full time on Saturday. The excess amounts to about $7,500 per year.

Sprinkling, flushing and weed-cutting are said to exhibit the same inefficient methods. Again, the hauls to most of the dumping grounds are excessive and many of the dumping privileges are temporary. One or more additional bunkers should be established on some railway line so that sweepings may be hauled away to various distant points. The report claims that the saving in team haul will more than offset the rail-haul charges.

The cost reports issued by the superintendent in his annual reports are termed valueless. No interest, capital or overhead charges are shown. Further, the present cost reports are based on the foreman's reports, many of which are falsified as to the areas swept. The reports should show in addition the work done per man or machine, per unit of time, and these figures should be given for comparison with previous years.

CONCLUSION

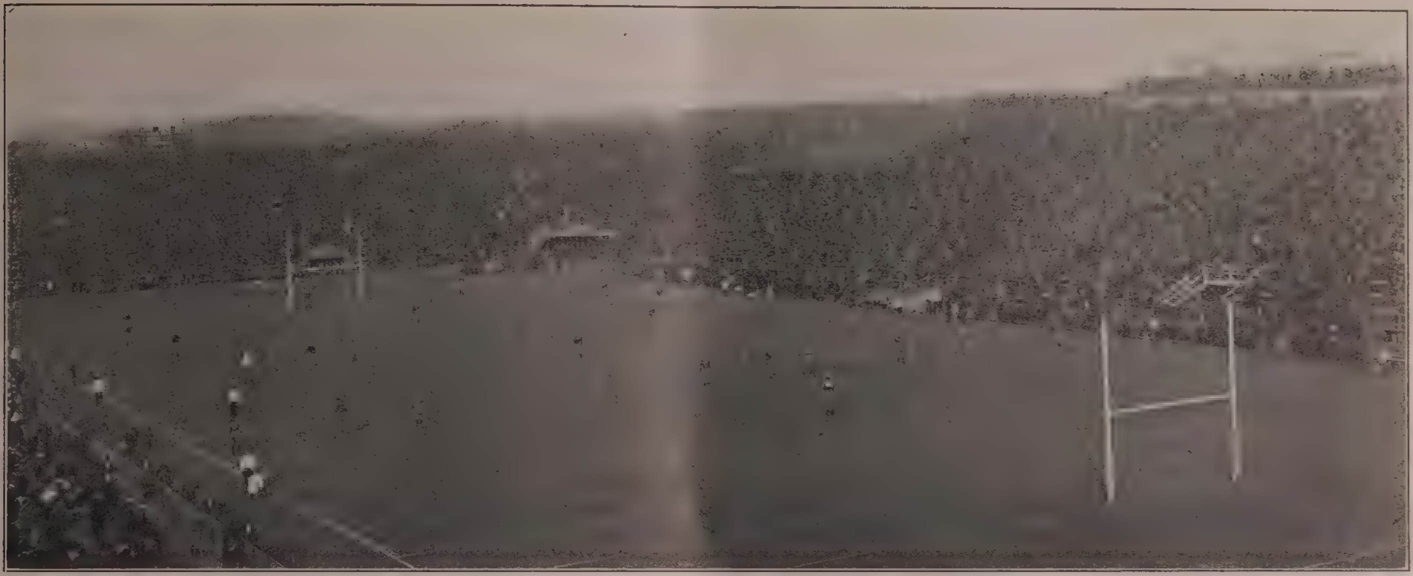
MR. CAMPBELL'S final remarks are as follows:

"In my opinion the only conclusion to be drawn from this investigation is that the street-cleaning department is operated in a very inefficient manner. Lack of executive ability is manifest on every hand. Ordinary business principles demand that heads of departments should be competent men, experienced in their work. But this superintendency is not filled in this manner. Long-established custom has made it one of the spoils of office. Following a change of the city administration there was a change of superintendents. It is apparent that the subordinates were quick to note that the new appointee was a stranger to his work. He is trying to run the department single-handed—a manifest impossibility when the work is entirely in the field and widely scattered. It would tax the energies of a competent man to secure efficient work by this method. There must be four or five competent foremen or assistant superintendents employed to supervise directly the various classes of work—the district gangs, the sprinkling and flushing crews and the blockmen.

"The entire city can be kept really clean at a cost within the present budget appropriation of $350,000 with a minimum wage of $3 per day of eight hours for laborers, $6 per eight-hour day for teams not driven by owners, and $6.50 per eight-hour day for teams which owners drive. That the city is not kept clean and that the work now done is at an excessive cost is entirely due to the inefficient superintendence for which the Board of Public Works is at least nominally responsible.

"The obvious remedy is the employment of a superintendent conversant with the city's needs, equipped by experience and executive ability to handle the work, vested with full and unhampered authority to operate his department and given a sufficient number of competent assistants to supervise adequately the various classes of work—holding him strictly responsible for results."

TIMBER preservation by salt is discussed in a Forest Service bulletin, which states that engineers replacing a railroad trestle recently burned along the north shore of Great Salt Lake, Utah, have found that the piles—local pine and fir—are still perfectly sound after forty-three years of service. At another point on the lake 18-in. piles, set twenty-nine years ago, are similarly preserved with salt which has penetrated to their very center. Timbers in the Southern Pacific trestles across Salt Lake, placed in 1902, appear to be as good as on the day when the piles were driven, being preserved well above the water line by the salt dashed on them by the waves.



Old Wooden Stands at Yale Field, Showing Number of Spectators That Must Be Accommodated

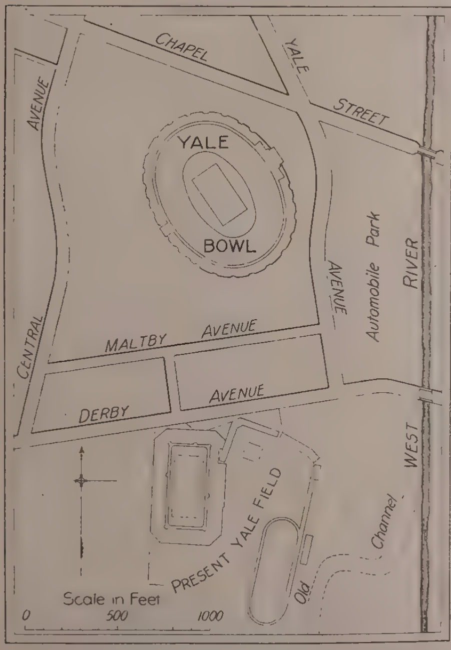
Yale Stadium to Seat 61,000 Spectators

Oval-Shaped Concrete Structure, Half in Excavation and Half on Embankment, with Steps for Seats Placed Directly on Sloping Ground

SIXTY-ONE THOUSAND spectators is the seating capacity of the oval, bowl-shaped concrete stadium, covering 12½ acres, which is being constructed at Yale Field, New Haven, Conn., to replace the present wooden grandstands which have been costing for maintenance alone from $10,000 to $12,000 per year. Ultimately the new structure may be extended by the addition of a balcony to accommodate 100,000 people, and in size will rival some of the ancient Greek and Roman amphitheaters. According to present plans, the Yale "bowl," as it is called, will be the scene of the Yale-Harvard football game next fall.

The center of the stadium is in excavation, while the upper part rests on a fill. The spectators gain entrance to the amphitheater through 30 tunnels. These terminate at El. 37 on the inside of the bowl, where the step is 3½ ft. wide, and will be used for a cross aisle. Below this aisle there are twenty-five steps; above it, thirty-five. The seats will be placed on these steps.

On the top of the embankment there will be a promenade 11½ ft. wide. Leading down from each spectator tunnel will be an aisle, but on the embankment above there will be two aisles between tunnel openings. All aisles are 3½ ft. wide. The arrangement is shown on the general drawing.



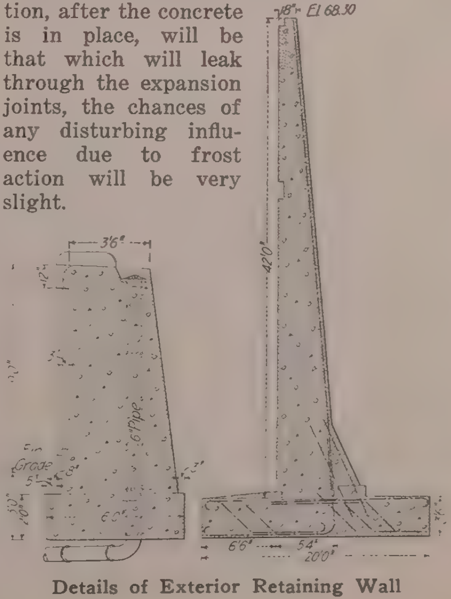
Location of Bowl and Present Field

STUDY OF FROST ACTION

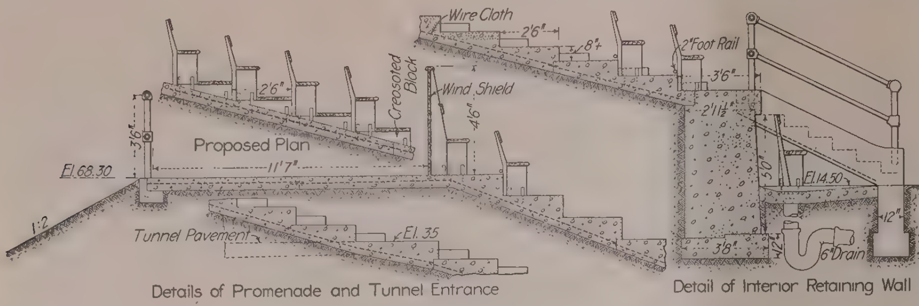
WHEN the plans were drawn several designs were prepared and discussed. One was a reinforced-concrete structure with columns and girders on which reinforced-concrete steps were placed. This design was found to be expensive, and the adopted scheme, half in excavation and half on fill, with concrete steps laid directly on top of the earth, was finally proposed by Charles A. Ferry, consulting engineer, of New Haven. This plan, however, brought forth criticism, and the theory was advanced that water freezing in the ground would cause heaving, thus breaking the steps. To obtain a basis for forming an intelligent opinion on the subject, the engineer made a few simple experiments along that line. The material at the field is a mixture of sand and gravel, varying from a very fine sand to cobbles 2 or 3 in. in diameter. Several tests showed that the voids amounted to from 37 to 40 per cent of the volume.

A sample of sand, taken about ½-in. below the surface of the ground a few hours after a storm, in which the precipitation was a little over 2 in., had 23.4 per cent of the voids filled with water. A bottle, about 10 in. high and about 1 in. in diameter, with a sharp contraction at the neck, was tightly packed with dry sand, enough water added to fill 23.4 per cent of the voids, and the contents frozen without any indication that the sand had expanded by freezing. Sufficient water was then added to fill 50 per cent of the voids, and the bottle again frozen, without signs of expansion. Water was again added to fill 75 per cent of the voids, and the freezing process repeated. This time there was expansion enough to crack off the bottom of the bottle. The indications were that the quantity of water was too large to allow its distribution throughout the sand by capillary attraction. It therefore settled to the bottom of the bottle, saturating the sand, and there being no unfilled voids to provide space into which the ice could expand, the increased volume had to be provided for by enlarging or breaking the containing vessel.

To test the capacity of the sand to retain water, a piece of linen was tied over the mouth of the bottle and the bottle filled with the dry sand, thoroughly shaken down. Water was then poured into the bottle until all of the voids were filled. The bottle was then turned upside down in a bed of sand, so as to reproduce natural conditions as nearly as possible. At the end of twenty-four hours 67.1 per cent of the water had leaked out, and at the end of eight days only 20 per cent of it remained. It was thought, therefore, that if sand would not "heave" when 50 per cent of the voids were filled with water, and that if only about 33 per cent would be filled after an interval of twenty-four hours after the sand was saturated, and that since the only water which can reach the sand foundation, after the concrete is in place, will be that which will leak through the expansion joints, the chances of any disturbing influence due to frost action will be very slight.



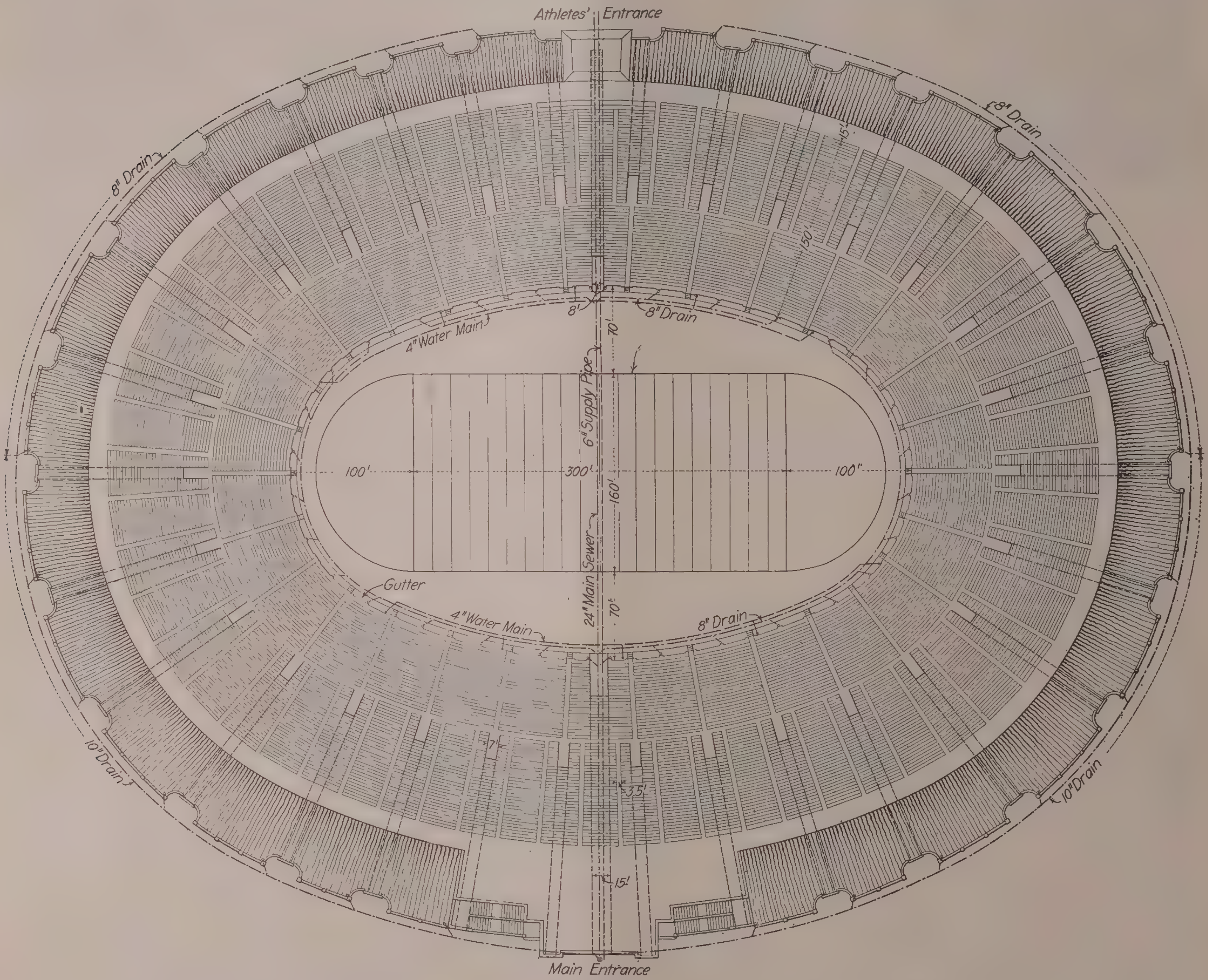
Details of Exterior Retaining Wall



Details of Promenade and Tunnel Entrance

Detail of Interior Retaining Wall

Steps for Seats, Inner Retaining Wall, Gutter and Stairs



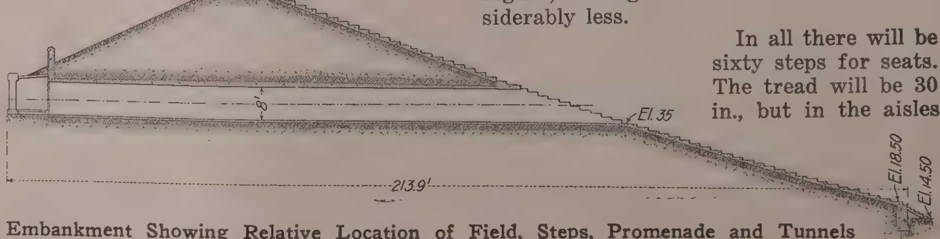
Yale Bowl, which Will Accommodate 61,000 Spectators; It Will Be Finished in Time for the Yale-Harvard Game Next Fall

Original plans contemplated a football field exclusively. Mr. Ferry's first plans, however, made provision not only for a football field, but also for a baseball diamond, together with a ¼-mile running track. The field in this plan was an irregular heptagon, which gave a rather poor view for the spectators seated near the angle points when a game was played at the opposite end of the field. An oval shape would have been better in that respect, and finally the bowl-shaped design was adopted. In the present plans the stadium has no baseball diamond but has a football field and a running track. The track is about 200 ft. short of a ¼-mile.

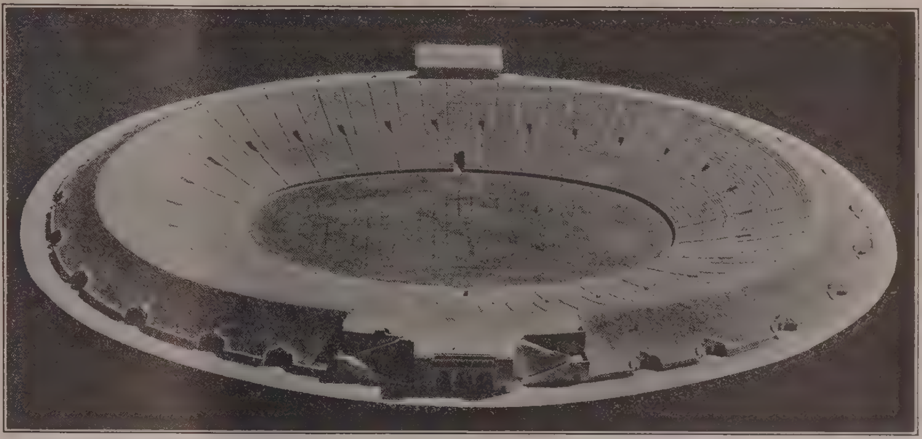
In designing the bowl the excavated part in the center was figured so that the material would be sufficient for the fill. In stripping, however, 22 in. of loam, forming the top layer, was not suitable for the embankment. It was, therefore, found necessary to take a small part of the fill from borrow pits. These were located in front of the main tunnel, where grading was necessary in order to meet the present grades of Yale Avenue and Chapel Street. In addition to this grading the marsh on the other side of Yale Avenue, reaching down to West River, will be filled in with surplus material, and will be used for parking automobiles.

The inside of the bowl will be covered with concrete, on which the seats will be placed. Whether this concrete surfacing will be placed in steps, on which the seats will be directly placed, or in a slope on which steps will be anchored, is not yet determined, but the first plan is the one more likely to be adopted. Both designs are shown herewith. The design with the concrete slab and the wooden steps has the disadvantages that the fire hazard is greater than with all concrete, the construction less permanent, and, consequently, the maintenance cost higher, although the first cost would be considerably less.

In all there will be sixty steps for seats. The tread will be 30 in., but in the aisles



Embankment Showing Relative Location of Field, Steps, Promenade and Tunnels



Model of Yale Bowl, Showing the Main Entrance in Front

there will also be an intermediate step, reducing the tread to 15 in. The riser height is variable, beginning at the bottom with 8 in. and increasing about 0.006 ft. per step, so that the uppermost is 12 in. high. This design gives the inside of the stadium a bowl shape, and hence the name. Several advantages are gained by this shape—one is that a standing spectator will block the view of only a few of those back of him.

To facilitate the construction of the steps and cheapen the cost of the seats the steps are not placed on the oval curves conforming with the shape of the stadium. These curves are replaced by chords from 9 to 20 ft. long, depending upon the curvature. The change from the true oval, however, is hardly noticeable because of the length of the radii of the curves.

The upper thirty-one rows of steps will be placed on fill. This fill is deposited in 6-in. layers, thoroughly moistened and rolled eight times alternately with grooved and smooth rollers.

Seating Capacity of 100,000

Although the seating capacity will be 61,000, the stadium is being built so that it can be extended to seat over 100,000. The plan is to place a roof over the upper thirty-five steps and place seats on top of it, thus creating a balcony. This addition will be placed on columns, which will eliminate two hundred of the present seats. The superstructure can be made of wood or reinforced concrete, preferably of the latter.

Gate House at Athletes' Tunnel, with Adjacent Spectator Tunnels

The outside slope of the embankment, which is 1 on 2, will be covered with grass. The lower end is supported by a 9 ft. retaining wall of gravity type, as shown on the drawing. At the gatehouse for the main tunnel the retaining wall is 45 ft. high, built of reinforced concrete. At the spectator tunnels there are gravity-section curved wing walls. Around the arena the fill is retained by a wall projecting 4 ft. above the field. It is of gravity-section. Its details are shown in one of the drawings.

Tunnels

There will be thirty spectator tunnels under the embankment. These are 7 ft. wide and 8 ft. high, and are numbered clockwise from one to thirty from the gatehouse at the main tunnel. As they all terminate at El. 37 on the inside of the bowl, and the outside ground has a slope, all tunnels slope either up or down, so as to be self-draining. The maximum upward slope into the stadium is 4.46 per cent and the minimum is 0.236 per cent.

There are two other tunnels besides the spectators' tunnels—the main tunnel and the athletes' tunnel. Their locations are shown on the accompanying plan. Both of them lead down to the arena, which is located at El. 14.5. The main tunnel has a continuous down grade of 6.326 per cent. It is 15 ft. wide and 10 ft. high, so that access to the field can be obtained for teams. The athletes' tunnel has two flights of stairs, separated by a landing, leading down to El. 26, and from there it continues at a down grade of 7.548 per cent to the field. Both of these latter tunnels have gatehouses, of which the one located at the main tunnel has lavatories. All tunnels have a granolithic pavement.

Expansion Joints

Expansion joints have been provided in all parts of the structure. The outside walls have one or two pilasters between each pair of tunnels, and slip joints have been located in these.

At every 30-ft. point in the tunnels there is an expansion joint. This joint is dowel-shaped in plan, so as to prevent leakage. It was constructed by means of a 3/16-in. bent steel plate, on one side of which tar paper was placed. The steel plate was supported on steel bars bolted to the inside of the forms. Concrete was deposited at the same time on both sides of this joint and the steel plate pulled up as the work progressed.

The tunnels are waterproofed on top with three layers of tarred felt and one course of tartex, all cemented together with pitch; the sides are pitch-mopped.

The concrete lining of the bowl—the steps for the seats—will have both radial and annular expansion joints. The seats will be placed on chords. At each chord intersection there will be a radial joint. At every third row of seats there will be an expansion joint along the step.

Water Supply and Drainage

Around the field, just inside the inner retaining wall, there is a 4-in. service water main connected to the city water-supply system by a 6-in. pipe. This system has hydrants at frequent intervals, to which

General View of Stadium, with Retaining Wall and Tunnels Completed hose can be attached for sprinkling the arena and the grassed embankment. Pipe wells have been driven from which water is obtained for concrete and for sprinkling the embankment, the necessary pressure being furnished by electrically driven centrifugal pumps.

The drainage is taken care of by a concrete gutter around the arena, which is connected with an 8-in. sewer underneath by 6-in. drains. Around the outside of the stadium there is a similar gutter at the top of the retaining wall. This is connected by 6-in. drains with a sewer that varies in size from 8 to 10 in. Both the inside and outside sewers are connected to a main 24-in. sewer, which carries the water to the West River.

The 6-in. drain will be placed in every panel, as shown in the plan drawing. At each aisle there will be a concrete stairway leading down to the arena. A few seats will be placed in front of the inside retaining wall to accommodate players, referees, and other officials.

Estimated Amounts of Materials

THE amount of concrete, exclusive of the lining of the bowl, is estimated at 15,000 cu. yd., and the steps for seats at 9000 cu. yd.; excavation, 300,000 cu. yd., including the stripping of the loam surface 22 in. thick; embankment, 175,000 cu. yd.; reinforcing steel and railings, 600,000 lb.; turfing field and the outer slope of the embankment, 75,000 sq. ft.; sewers and drains, about 6000 lin. ft., and pavement in the tunnels, 40,000 sq. ft.

The estimated cost, including gatehouses and the improvement of the surrounding property, is about $400,000, while the cost of the bowl itself is about $300,000. The total cost makes an average of a little over $6 per seat. This amount compares favorably with the cost of other stadia. That of the Boston Baseball Club was about $24, and the Harvard stadium about $13.

The adopted plan was proposed by Charles A. Ferry, who is resident engineer of the construction, with E. G. Williams as advisory engineer, and Donn Barber as architect. The work is being done under the direction of David Daggett, chairman of Structures Committee.

Turbidity in Lake Michigan

TURBIDITY in Lake Michigan water at Waukeegan, Ill., for the last eight months averaged 40 parts per million, with a maximum of 325 parts in November. High turbidities during each of the months from July last year to February, inclusive, were 5, 73, 210, 180, 325, 260, 200 and 100. Average bacterial counts for the same period were 2300 per cubic centimeter, with 50 per cent of the 1-cu. cm. samples showing tentative positive B. coli indications. After bleach treatment, as described at the recent meeting of the Illinois Water Supply Association by W. J. Allen, chief engineer of the waterworks, bacteria averaged 115 per cubic centimeter, and 8 per cent of the two hundred and forty-three 1-cu. cm. samples gave the gas reaction in the test for B. coli. On the average, 0.516 part per million of bleach was used. Frequent tests on the treated water with starch and potassium iodide are made to keep about the same quantity of residual chlorine in the water. Mr. Allen found the wait for the bacterial results too long to be of value in changing the rate of bleach application.

Reconstruction of the Elwha River Dam

Undermined Concrete Structure, 112 Feet High, Supplied with a New Foundation Blasted from the Canyon Walls

By VICTOR H. REINEKING
Engineer in Charge

THE dam built for the Olympic Power Company across the Elwha River near Port Angeles, Wash., and which was undermined on Oct. 30, 1912, has been provided with a new foundation, as it were, and is once more in service, with water flowing over the spillway at a level more than 100 ft. above the hole through which it escaped beneath the structure for more than a year. Although at the present time considerable work remains to be done to bring it to completion, the success of the methods employed is assured, and a satisfactory repair can now be considered an accomplished fact. An account of the failure was given in the Engineering Record of Nov. 12, 1912, and announcement of the success of the heavy blasts appeared in the issue of Nov. 15, 1913.

The dam is a gravity-type concrete structure built across a canyon about 120 ft. wide at the top and with a bottom width varying from 80 ft. on the upstream face to 45 ft. at the toe of the dam. At El. 80, which is the normal tail-water level, the structure has a thickness of 97. The dam was calculated to hold back a head of 100 ft., but about ten days after the pond was first filled water found its way under the foundation and washed out an opening large enough to pass the entire storage of 12,000 acre-ft. in one and a half hours. Throughout the ensuing year this hole passed the entire flow of the stream beneath the dam, which stood spanning the gap like a bridge, its main portion uninjured by the washout.

As soon after the accident as possible the Olympic Power Company secured a 4-in. Star drill and a 6-in. Keystone drill and commenced to make borings both above and below the dam to determine the nature of the underlying strata. The canyon walls adjacent consist of conglomerate rock, very similar to concrete, and it was desired, if possible, to locate a site on which a new dam could be built for a sum less than that required for repairing the old one. To this end borings were extended 800 ft. upstream from the face of the dam and 400 ft. downstream from the toe. No suitable site was found, however, and the borings were then concentrated immediately above and below the dam. Bedrock was found in this vicinity at sea level, or about 70 ft. below the base of the dam.

Sheet Pile Caisson below Dam

The method of procedure in boring, since cores could not be secured, consisted of driving a pipe casing and churning the material within by means of a drill, the casing being then pumped out, driven further and the process repeated. The rate of penetration, together with the substances which were pumped out, indicated very clearly the nature of the material which was being encountered. This method gave no positive way of distinguishing between boulders and bedrock, but the holes were drilled from 10 to 25 ft. into rock where this material was encountered. Frequently holes that were drilled through boulders had to be abandoned because of refusal of the casing. Logs were another frequent cause of abandonment, although casings were driven through these in some instances. A great many logs were encountered in the natural pond area above the dam site, where they were found at all depths up to 35 ft. below the river bed. The drilling progress varied greatly in the loose material, but an almost uniform rate of 4 ft. in ten hours was made when drilling in the rock 100 ft. below the water surface. As a rule the drills were worked from scows with a crew of one engineer and one fireman.

Plan of Reconstruction

THE canyon walls immediately above and below the dam are very irregular in shape and composition; in many places they overhang, and crevices and faults run in every direction. Great difficulty was experienced in the original construction work in unwatering the foundation and, as near as can be learned, the water was never lowered to a depth greater than 20 ft. below the original normal water level. In considering a method of repair this fact, together with the great depth of bedrock and the presence of so many logs in the river bottom, led the consulting engineers to abandon any plan which necessitated unwatering the site. As finally adopted, the plan of reconstruction consisted essentially of a heavy rock fill above and below the dam, deposited and made tight as indicated in the following description.

The first step of the reconstruction was the driving of two rows of 50-ft. interlocking steel-sheet piling at right angles to the canyon, one row being driven about 10 ft. from the toe of the dam and the second about 70 ft. below. A third row of piling 40 ft. in length was driven about 150 ft. downstream from the toe. All of this was driven so that the tops of the piles were flush with the bed of the stream, thus tend-

Panoramic View from Downstream Side of Dam, Showing Spillways and Power House

ing to decrease the underground flow through the gravel of the stream bed without interfering with the flow of the stream itself.

Between the first two of these rows of steel sheeting a rectangular inclosure or caisson 20 ft. wide by 50 ft. long was formed by driving steel sheeting in 40 and 50-ft. lengths, as shown in the drawing and photograph. The loose material within this inclosure was excavated to a depth of about 30 ft. and the space then filled with concrete, no attempt being made to unwater it. The concrete was placed with a derrick handling a 1½-cu. yd. bottom-dump bucket, which was lowered to the bottom of the excavation and then tripped by hand by means of a rope. This method of placing the concrete under water was very successful. There were no indications of cement finding its way through the sheet piling and but little disturbance was created within the inclosure when the bucket was tripped. The purpose of this block of concrete was to form a heavy stubbing block to assist in holding the rock in place, which was to be afterward brought down by blasting. The preliminary construction on the upstream side of the dam consisted of two rows of interlocking steel piling, one row being about 15 ft. from the face of the dam and the second about 95 ft. from the face. Both of these rows were driven down flush with the stream bed, the same as the three rows behind the dam.

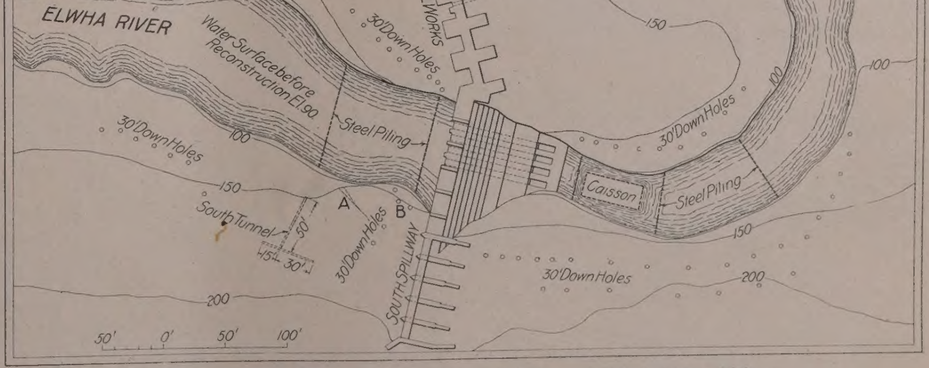
The essential feature of the reconstruction was the depositing of the rock fill below the dam and the rock and earth fill above. The canyon walls for a distance of 300 ft. above and below the dam rose perpendicularly to a height of 60 ft., offering excellent opportunities for depositing large quantities of rock in the stream by means of blasting. It was essential for the successful consummation of the plans that the rock and earth fill to be used in stopping the hole under the dam should be deposited almost instantly, and that the material to be used for this fill be well proportioned so as to contain a minimum percentage of voids. To accomplish this, heavy blasting in the immediate vicinity of the dam was necessitated. While preparations were being made for the blasts, large quantities of earth were placed on the rock to be blasted so that this material would be deposited simultaneously and be well mixed with the rock.

DRILLING FOR POWDER CHARGES

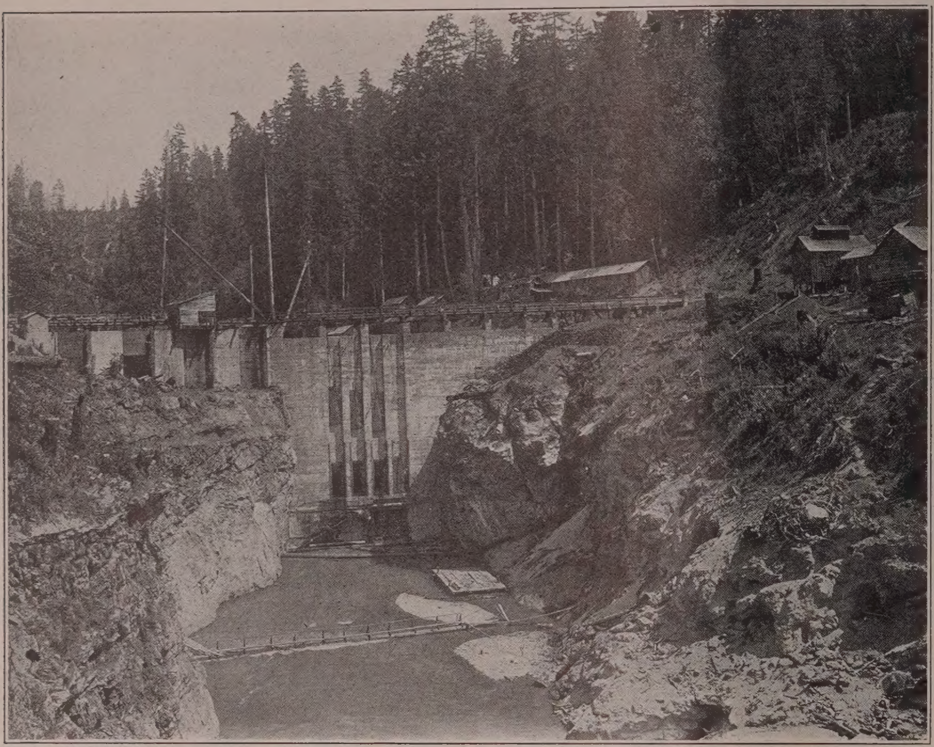
ONE of the accompanying drawings shows the plan adopted for the blasting, both above and below the dam. The drilling below the dam consisted entirely of 30-ft. down holes placed as shown on the drawing, but above the dam the problem was more complicated, and the location of the powder holes was made the subject of careful study. The drilling above the dam was laid out so that the concrete structure would be protected as much as possible from the very large charges of explosives which would have to be used in order to meet the requirement of moving a great quantity of rock into the stream bed all at once. It was finally decided to drive a tunnel or gopher hole 3 ft. square on each side of the gorge as shown in the plan drawing. The main shafts of these tunnels were 50 ft. long, the branches being 30 ft. and 15 ft. in length, as shown. A pocket or powder pit 5 ft. wide and 7 ft. long, for the reception of the powder, was blasted at the end of each of these branches, these powder pits being located about 70 ft. vertically below the rock surface of the steep-sided gorge.

In order to protect the concrete dam from shock of the blasts, a row of down holes, 30 ft. deep, was drilled between the pits and the dam. These holes were so located that every advantage of seams in the rock was taken. Another row of down holes was drilled between the upstream powder pits and the canyon walls, to assist the larger blasts.

The drilling in the tunnels was done by means of two Ingersoll-Rand jackhammer drills, one working in each tunnel, two workmen manning each machine. A uniform progress of 3 ft. per day was made by the two men, including drilling, blasting and mucking. The down holes were all drilled with an Ingersoll-Rand E44 rock drill, being operated by two men, who drilled on an average 30 ft. per day. Air for these drills was furnished by an Ingersoll-Sargent air compressor with a capacity of 1200 cu. ft. per minute on the low pressure side. A 60-hp stationary



Plan of Dam, Showing Location of Lines of Steel Sheet Piling



Upstream Side of Dam with Line of Piling in Foreground

boiler furnished steam. Drilling was done in ten-hour shifts.

Incidental to the reconstruction of the dam, it was found necessary to increase the spillway capacity of the plant. While space cannot be given in this article to the details of this work, it may be said that rock amounting to about 6000 cu. yd. had to be excavated from the approach to the new south spillway. This excavation was deposited in front of the dam and some of it was carried by the current into the hole washed out underneath the structure. However, careful soundings in the stream bed below the dam showed no traces of any of this rock passing the concrete stubbing block.

BLASTING

SEVERAL weeks before work was ready for the firing of the heavy charges above the dam blasting was begun on the down holes below the dam. These were usually shot in batteries of about six holes at a time. The holes were so sprung that they could be loaded with a charge equivalent to ¾ lb. of powder for each cubic yard of rock to be moved. Whenever the holes were dry enough, black powder was used, but when the holes were wet, 60 per cent gelatine was substituted. This charge was found strong enough to deposit very large rock in the river, but did not have strength enough to break it up to any great extent. The blasting below the dam, which raised the water about 20 ft., gave a fill here consisting principally of rock varying in size from 2 to 40 tons. Altogether about 20,000 cu. yd. of rock were deposited on the downstream side of the dam.

The powder pits of the tunnel on the north bank of the stream were loaded with No. 3F black powder and contained a charge equivalent to 1¼ lb. of powder to a yard of rock to be removed. The down holes on this side were loaded with black powder and gelatine at the same rate of charging as the tunnels. The tunnel on the south side was too wet to permit the use of black powder and was therefore loaded with 60 per cent gelatine, the charge used being 1 lb. of powder to the yard of rock to be moved. The down holes between the powder pits and the dam were loaded with 80 per cent gelatine, while in the others 60 per cent gelatine was used.

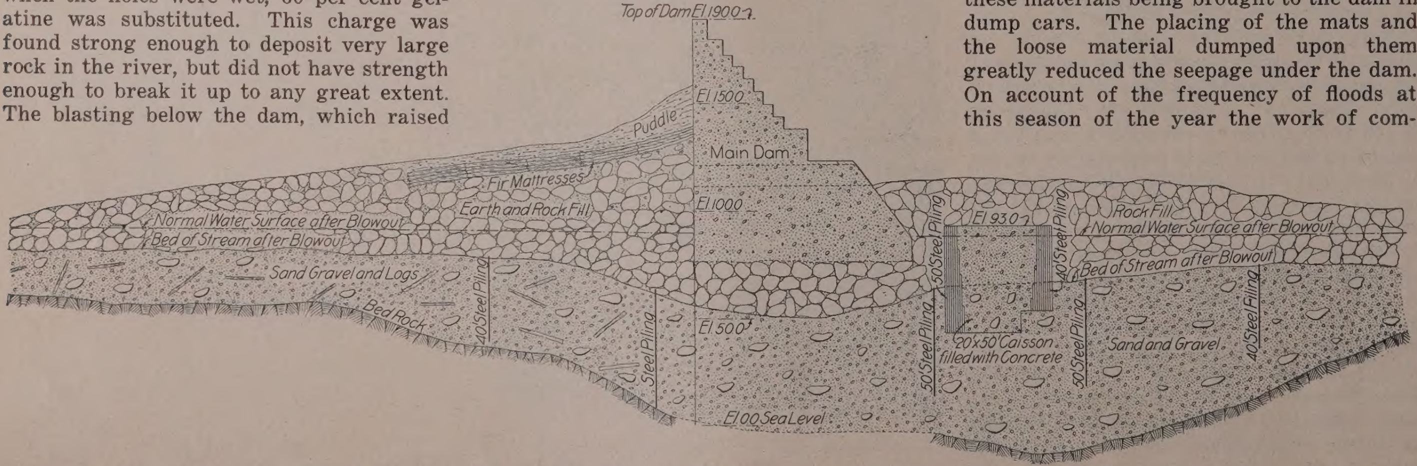
The sequence of shooting these charges was as follows: The down holes marked A, together with a charge of powder placed in a large seam in the rock, marked B, were to be set off simultaneously, and immediately thereafter the two tunnels and the remainder of the down holes were to be discharged. The charges in the tunnels were to be preceded by these smaller charges, so that the latter might form a cushion which would deaden the severe shock to the concrete dam when the tunnel charges were fired. This theory proved correct, for after the blasting was completed there was no indication of any damage to the concrete work. On account of a misfire the two tunnels were not set off simultaneously, but the result of the blasting was probably in every way as satisfactory as though they had been fired as planned.

The total charge in the tunnels and down holes above the dam consisted of 25,000 lb. of black powder and 20,000 lb. of gelatine. The center of gravity of the charge was about 110 ft. from the face of the dam. About 50,000 cu. yd. of material were moved, and of this amount about 40,000 cu. yd. were deposited almost simultaneously. The material was well proportioned and lay very evenly distributed in the river bed.

FIR MATS

THE effect of the fill deposited as described in the foregoing was to raise the water in the pond so that in three days' time it began to flow over the north spillway. There was, as expected, considerable seepage through the fill under the dam, and to assist in stopping the seepage fir mats were built, each 30 ft. wide and 50 ft. long and approximately 3½ ft. thick. In making these mats, fir boughs were tied up with No. 9 black annealed wire into facines about 15 in. in diameter and about 30 ft. long. These facines were then placed side by side on a pole framework, consisting of 6-in. poles, spaced 6 ft. on centers each way and forming a frame the size of the mat desired. The facines were placed as close together as possible and each was tied to the frame with wires. When the first layer was fastened in place, a second layer was placed on top and at right angles to it. This was followed by a third parallel to the first, and all securely wired together. A pole frame similar to that used on the bottom of the mat was then placed on top and the whole securely wired together by running wires from the lower to the upper frame. The mats were then pulled off the ways on which they were built and floated into place. Each mat required to be loaded with about 5 cu. yd. of loose rock before it would sink. The mats cost approximately $100 each, including cutting boughs, hauling, etc., the rate paid for labor being 30 cents per hour.

The mats were placed on the upstream side over the entire area within 150 ft. of the face of the dam, after which they were covered with a fill of loose rock and earth, these materials being brought to the dam in dump cars. The placing of the mats and the loose material dumped upon them greatly reduced the seepage under the dam. On account of the frequency of floods at this season of the year the work of com-



Sectional Elevation, Giving Location of Sheet Pilings, Concrete-Filled Steel Caissons, Stone Fill and Method of Tightening It pleting the fill on the mats has been postponed to the summer months. Meanwhile there is still some seepage passing under the dam, but more water is now available for power purposes than will be required for some time by the power company.

George A. Glines, of Winnipeg, Man., is president and T. T. Aldwell, of Port Angeles, is general manager of the Olympic Power Company. Daniel W. Mead and Charles V. Seastone, of Madison, Wis., are the consulting engineers, and J. O. Heyworth, of Chicago, Ill., was the contractor.

Book Reviews

The National Council for Industrial Safety has issued a 200-page volume containing the proceedings of the Second Safety Congress held at Hotel McAlpin, New York, Sept. 23 to 25, 1913. The material is of much practical interest and value to those furthering the cause of accident prevention and throws light upon the everyday aspects of the work. (Chicago, National Council for Industrial Safety, Continental and Commercial National Bank Building.)

Tables for computing the cost of tile drains have been compiled and published in blueprint form by J. L. Parsons, civil and drainage engineer, of Humbolt, Iowa. The pamphlet has 9 sheets, of which the first gives the rules for using the tables. The remaining 8 sheets have 24 tables giving cost per 100-ft. station at different prices per 3 ft. depth, one rod in length, and different prices per inch over depth. The costs are also given per 100 ft. at different prices per cubic yard of earth excavation, with rules for use of tables. The last table gives equivalent decimals of a foot and inches. The cost of the tables is $1.

The floods of 1913 in the rivers of the Ohio and Lower Mississippi Valleys are the subject of Bulletin Z of the Weather Bureau of the U. S. Department of Agriculture. The author is Alfred J. Henry, professor of meteorology. He begins the book with a résumé of the floods of the Ohio River from 1870 to 1913. The basin, contributing causes, individual floods before the period of systematic observations, floods of the later period and recapitulation of floods during the last forty years are dealt with in this part. The flood of March, 1913, is then investigated and the precipitation tabulated. Other tables give the hourly river gagings at Parkersburg, W. Va., and the daily river gagings on the Lake Erie and Ohio River systems. Charts give the rainfall in the Ohio River watershed during March 23 to 27, 1913, and comparable charts for other periods.

Flood in the lower Mississippi River is the subject of the following part. It is accompanied by a chart showing the flooded district and a hydrograph giving the river stages from February to May at points from Cincinnati to New Orleans. The last part of the book contains papers on floods in Ohio, Indiana, Illinois, Kentucky, New York, New England and the lower Mississippi Valley. Of special interest is the paper by Robert E. Horton on frequency of recurrence of Hudson River floods. The cost of the book is 40 cents.

The Engineering Index Annual for 1913. Cloth, 6¾ x 9¼ in.; 508 pages. New York, The Engineering Magazine Company, $2 net.

This is the twelfth issue of this well-known index, and the eighth since it assumed the annual form. With its predecessors it forms an unbroken record of the enormous amount of technical material which has appeared in magazine form over a period of thirty years. The general arrangement of the index, familiar to all engineers, has been retained, though as a result of constant study the number of classifications has been increased, cross-referencing has been multiplied and methods of classifying certain sub-topics have been improved. In the present volume about 250 publications are indexed, among those added being the proceedings of the Institution of Mining Engineers and the Faraday Society. About three-fourths of the journals covered are printed in English, the others being in German, French, Spanish Italian and Dutch.

Continuous and Alternating Current Machinery. By J. H. Morecroft, Assistant Professor of Electrical Engineering, Columbia University. Cloth, 5¼ x 7¾ in.; 466 pages; 288 illustrations. New York, John Wiley & Sons, Inc. $1.75 net.

This book is one of the Wiley technical series designed to meet the needs of vocational and industrial schools. It is, therefore, an elementary work, which, nevertheless, could well be used in engineering colleges for those courses in electrical machinery planned for civil engineering students. It is sufficiently complete to give an idea of the theory, purpose, construction and operation of the chief continuous and alternating-current machines. In particular it will give an understanding of the characteristics of the different types of motors, with explanations thereof—a most important matter to the occasional purchaser of such equipment. The book, obviously, is also of value for practising civil engineers for reference purposes. The principles of continuous currents are first taken up, then continuous-current generators and motors. These chapters are followed by a presentation of the elementary principles of alternating currents, and chapters on alternating-current generators and motors, transformers, converters and auxiliary apparatus. The closing chapter is on the operation and care of electric machinery.

Investigating an Industry. A Scientific Diagnosis of the Diseases of Management. By William Kent, Consulting Engineer, With an Introduction by Henry L. Gantt. Cloth, 5 x 7½ in.; 126 pages. New York, John Wiley & Sons, Inc. $1 net.

This book is an interesting story of the work of an "industrial doctor" in analyzing the troubles of a whole industry—not of the factory alone, which is generally the limit of the province of the specialist in scientific management, but also of the selling department and the general administration. The whole method of analysis is given, working up finally to a functional committee system, operating not only in the factory, where such committees are not by any means new, but also in the board of directors. The book is not written with the purpose of outlining the details of highly efficient factory or selling-force management but rather to give executives an idea of the wide scope that can be taken by scientific investigation of the needs of an industry. It should be a stimulus for such men to undertake like studies in their own plants.

Letters to the Editor

Wheat Grows on Concrete Floor

Sir: Here is a rather peculiar incident in concrete work which came to my notice to-day: On Feb. 10 we ran a concrete floor on a 50 x 142-ft. building. That night a drop in temperature demanded action to prevent freezing. We took baled wheat straw, scattered it over the floor about 4 in. deep, and covered it with canvas. Coke fires were started on the floor below and continued burning until Feb. 27. The temperature has ranged from 32 deg. above zero to 10 deg. below, and there have been two heavy falls of snow. The snow thawed to some extent, causing water to stand on the concrete.

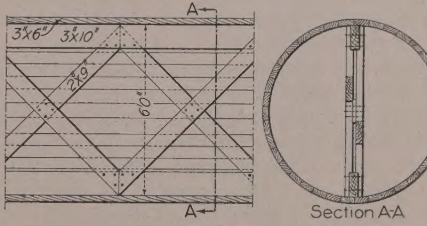
When the straw and canvas were removed (temperature, 50 deg. above zero) green wheat beards were found growing about 2 in. high. Despite the superintendent's word that the concrete was not frozen, the owners and others interested had some fears to the contrary. The growing wheat is the best of proof, it seems to me, that the floor is satisfactory.

Lincoln, Neb. F. H. Misner.

Supporting Large Pipes

Sir: In your editorial entitled "Supporting Large Pipes" in the issue of Feb. 28, page 237, it is stated, substantially, that no effort has been made to make wood-stave pipe self-supporting in spans of any magnitude. It may be interesting, if not instructive, to know what was done in that direction more than 60 years ago. The writer is fortunately enabled to speak with exactitude as to what he writes, for the design herein shown, in longitudinal and cross-section, was designed, constructed and erected by a relative and the original plans are before him.

At the Oriskany Valley Woolen Mills, near Oriskany, N. Y., it became desirable to carry a 6-ft. wood-stave pipe, or "trunk," as it was then known, over a span of 37 ft. 8 in., and it was necessary that the space below be unobstructed. This pipe was constructed of 3 x 6-in. hemlock, sawed to approximate size and beveled and rounded, outside, by hand. It was banded with ⅞-in. round iron bands, welded to exact size; tightness was secured by driving wedge-shaped terminal staves. This pipe was erected on falsework and after completion the wooden truss shown was erected inside. This truss was of birch and was undoubtedly framed and erected with all the niceties of workmanship and finish characteristic of the old-fashioned millwright. A notation on the margin of the plans states that when filled with water the trunk sagged in the center ⅜ in.



Pipe with Inserted Truss

This structure was erected about 1854 and performed its duties until about 1883 or 1884, when the mills burned and were never re-erected. While the design shown may be open to criticism, it is a fact that it answered its purpose and, for those days, showed considerable originality.

Utica, N. Y. W. G. STONE.

[Mr. Stone's letter seems to be based on a misunderstanding of the editorial in the issue of Feb. 28. Steel pipes were spoken of and it was mentioned that such pipes could be made self-supporting over long spans simply by arching them. In that connection wood-stave pipes were referred to, and it was stated that, "as far as this journal is aware, this scheme has never been used." The Saxon Falls pipe line was cited as a step in the right direction because the pipe was supported on longitudinal stringers, thus eliminating large reactions on the pipe at points of support. Inside of the pipe line referred to by Mr. Stone is a truss, which naturally also eliminates reaction on the pipe.—EDITOR.]

Erection of Panama Lock Gates

SIR: My attention has been called to an error in your issue of Jan. 3, page 20, in which you have misspelled my name in the middle of the center column. The lowering wedges used on the Rocky River Bridge were devised by the undersigned and not by Wilbur J. Rockland, as you have it.

Cleveland. WILBUR J. WATSON.

Sewage Treatment by Aeration

SIR: I am pleased to note the renewed attention that is being given to the question of aeration of sewage tank effluents as a means of increasing nitrification in contact or filter beds. The idea is not new but application of it has never proved entirely successful until within a few years past. Colonel Waring's scheme of forcing air through filter beds by mechanical means would have been successful had he not overdone the matter.

Dr. Hering, while at Leipsic, Germany, in 1910, obtained information regarding some experiments of the aeration of coarse stone filter beds that resulted in increasing nitrification thereby 50 per cent. Alfred Vogelsang of Dresden took out patents in 1906 on a method of constructing filter beds in such a way that atmospheric air would be induced into them in an opposite direction to that of the applied sewage or tank liquid "for the purpose of increasing the efficiency of the biological body." Mr. Vogelsang says: "This may be accomplished by constructing the whole bed in a close receptacle which at the bottom is in free communication with the atmospheric air and connected at the top with a chimney or ventilating flue."

I was gratified on receiving this information late in that same year for the reason that I had long advocated the artificial introduction of air into nitrification beds and had for several years included in designs and construction of sewage disposal plants that embodied induced interior aeration, and in 1907 took out Patent 848,279 and also Patent 956,665 in May, 1910, which embodied the feature of the artificial interior aeration of beds.

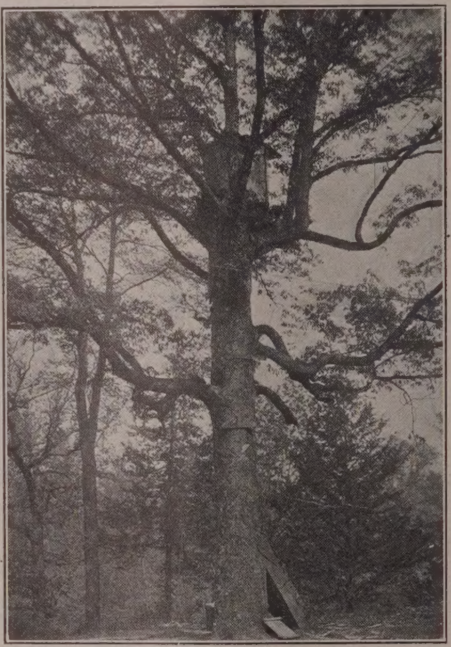
The sewage treatment plant at Atlanta, Ga., is a notable example of the carrying out of this idea in the United States and I believe is one of the first of its kind to be used in municipal corporation plants. A similar scheme for the internal aeration of contact beds will be introduced into a sewage treatment plant now under construction at the Cook County Poor Farm, Oak Forest, Ill., by the use of air intakes of the character used by Mr. Vogelsang and myself.

BURTON J. ASHLEY,
Chicago. Consulting Engineer.

An Arboreal Water Tank

SIR: The photograph on this page shows a new design for an elevated tank mounted in a tree. It is used to supply water to one or two houses in the vicinity of Clarksdale. The water is pumped into the tank by a hydraulic ram from a mountain stream.

M. J. TREES,
Chicago Bridge & Iron Works.
Chicago.



Tank Mounted in a Tree

Mixed vs. Penetration Roads

SIR: Permit me to express my interest both in your editorial in your issue of Jan. 24, page 89, under the heading of "Mixed vs. Penetration Roads," and in the letters on the same subject printed in your issue of Feb. 7, pages 175 and 176.

It is evidently natural, because of the frequency with which one notes the fact, for those whose experience may have been restricted in construction to the use of one of these two methods or whose observation of construction has been limited to a short period, to become perhaps prejudiced in favor of one of the methods to the exclusion of the other. The writer will not pretend that even he may not be prejudiced in the matter to some extent because of his greater familiarity or actual experience in construction with one of the methods. However, he feels that his observation of other methods has been sufficient to make him at least appreciate their possibilities. Therefore it seemed to him that your editorial referred to was in the main fair and sound and that the letter of Clifford Richardson was of the same general character.

The writer regrets that Mr. Richardson saw fit to make, as definitely as he did, certain statements, some of which he thinks Mr. Richardson will, perhaps, on further consideration, wish to qualify somewhat. For instance, Mr. Richardson says: "It must, of course, be remembered that a suitable amount of bitumen must be used in the penetration process and that this cannot be reduced below 2 gal. to the yard inclusive of the penetration and seal coat for 3-in. work."

Mr. Richardson will doubtless remember the section of Park Heights Avenue near Baltimore, built in August, 1910, where but 1.45 gal. of Bermudez asphalt were used per square yard, which is in good condition today, and on which the total maintenance charges for repairs to the macadam itself to date have been less than 1 cent per square yard for this period of three and one-half years.

Reference to the paper of the writer presented to the special meetings of the American Society of Civil Engineers in January, 1913, concerning Park Heights Avenue work ("Proceedings" of the American Society of Civil Engineers, September, 1913, page 1703) will show at least ten sections aggregating about 30,000 sq. yd., in each of which less than 2 gal. per square yard were used with success. The writer has built a number of short sections successfully with as little as 1½ gal. of pitch per square yard, and he is inclined to the opinion, as the result of his experience and of the observation of the experience of others, that more danger to the results is likely from the use of more than 1¾ gal. per square yard than when the use of the pitch is limited to between 1¼ and 1¾ gal.

The writer, therefore, feels that because of the wide respect accorded to any statement from Mr. Richardson, it is unwise to allow Mr. Richardson's statement on this point to go unchallenged, and this is his excuse for this letter.

W. W. CROSBY,
Baltimore. Consulting Engineer.

[Copy of Major Crosby's letter was submitted to Mr. Richardson, whose reply follows.—EDITOR.]

SIR: I am very much obliged to you for sending me a copy of Major Crosby's letter before its publication. I have read it and also have read my communication to you, and I cannot see that there is any occasion to reply to it. His point of view and mine are merely the result of differences of opinion. Perhaps he may be right with the residual products, but he certainly is not where the native asphalts are used.

CLIFFORD RICHARDSON,
New York City. Consulting Engineer.

Lettering Boundary Lines

SIR: We have had some discussion in regard to the proper method of writing the courses upon a traverse or property boundary line which is to accompany a deed or description of the property line. Should the courses and distances be written along the line in the direction in which the description is to be read, even though by so doing the courses must be written upside down and read from the bottom of the map? Or is it allowable to turn it right side up regardless of direction in which the description is being read? I can find no decisive answer to this question in any book I have, and if there is a regular practice I would be very glad to know it.

Lancaster, Pa. F. H. SHAW.

[Possibly some of the readers of Engineering Record can supply the information requested by Mr. Shaw.—EDITOR.]